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A STUDY OF FARM, HOME, AND COMMUNITY CONDITIONS IN A FARM VILLAGE OF ILOCOS NORTE AS A BASIS FOR FORMULATING A PROGRAM OF RURAL EDUCATION [1]

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The Philippines is primarily an agricultural country, with a large proportion of its population living in farm villages. In its desire to improve conditions in the rural districts, the Philippine government has created new agencies. Among these are the Office of Adult Education, the Rural Progress Administration, the agricultural extension service under Act 85, and the national schools of agriculture. Instruction in agriculture has also been introduced in many provincial high schools. Of the various workers now engaged in rural improvement, the agricultural supervisors and inspectors and the teachers of agriculture play the leading part. In order that they may be able to formulate an effective program of rural improvement, they should survey the problems and needs of the village community and secure an accurate understanding of barrio conditions. According to Smith and Wilson (1930), "the extension program should be based on the needs of the people to be served." Wheeler (1925) stated that the farm survey is "to determine what enterprises should be selected for the organization of farmer-training courses in a given community."

Review of literature

Studies on the economic conditions of farmers have been made by Hester and Miñano (1921), Hester, Mabbun, et al (1924), Royeca (1927)[2], Aala (1935)[3] Dalisay (1938), Castro (1939)[4], and Mañgila (1939)[5]. Everyone of these studies, however, considered only tenant farmers, and was not confined to a single barrio but included tenants from several barrios. Agbanlog (1930), Bandong (1930)[6], Meneses (1932)[7], Velmonte, Sumagui, and Viray (1934), in their studies on

[1] Experiment Station contribution No. 1392.

[2, 3, 4, 5, 6, 7] Unpublished theses on file in the library of the College of Agriculture.

the cost of living of farm families, also reported data on social conditions, such as size of household, housing facilities, and literacy. Each of these studies was also not confined to a single barrio, which is considered the logical unit for community improvement work.

Objects of the study

The objects of this investigation were to study: (*a*) farm conditions, such as types of farming, size of farms, crops grown, livestock raised, farm practices, and farm income, (*b*) home conditions, such as size of household, nature of dwelling, household facilities and conveniences, and homeground beautification and (*c*) community conditions, such as educational facilities, educational attainment, literacy, organizational membership, and social and recreational activities.

Time and place of the work

The study covered a period beginning December, 1938, and ending December, 1939. The greater portion of the field work was done during the summer of 1939, in the barrio of Nagbacalan, municipality of Batac, province of Ilocos Norte. The data on the farm business covered the preceding farm year, ending April 30, 1939.

MATERIALS AND METHODS

All the 136 farm homes in the barrio were included in the study. The survey method was employed. A survey form was used in collecting and recording the data. The information was secured largely from the husbands and wives and older children.

RESULTS AND DISCUSSION

Description of the area surveyed

The barrio (farm village) of Nagbacalan is in the northeastern part of Batac, province of Ilocos Norte. It is in the rice region of northern Luzon. A distinct wet and dry season prevails.

The center of the barrio is about four kilometers from the poblacion (town proper). It is accessible by a road which is passable only by pedestrians, sleds, and bicycles. The barrio is bounded on the southwest by a pond, and by hills on the other sides. Since the area is hilly, only one-half of the barrio is used for crop production. A small river crosses the barrio.

Aside from a school which gives complete primary instruction (grades 1 to 4), there are no other social centers, such as public

market, store, or chapel. These social facilities are, however, available in the poblacion.

Population

The resident population of the barrio numbered 684. Farming was the main occupation of the people. About 91.9 per cent of the household heads were engaged in farming. The others were: cloth weavers, 5.9 per cent; housewives, 1.5 per cent; retired farmer, 0.7 per cent.

About 72 per cent of the husbands and 60 per cent of the wives were born in the barrio. Only 5 per cent of the husbands and 3 per cent of the wives were not born in the municipality of Batac. All were born in the province of Ilocos Norte. The household heads have resided in the barrio for an average of 41.2 years, and in the municipality of Batac for 45.6 years. The foregoing figures show the extent of mobility of farm families.

Farm conditions

Farm ownership. Of the 136 household heads, 48.5 per cent were operating their own farms, 41.2 per cent were owners of portions of the farms they operated, and only 2.2 per cent were tenants. Of those engaged in farming, only 3, or 2.2 per cent, did not own a piece of farm land.

Type of farm. The dominant type of farm was rice, which included 97.6 per cent. The other three types were: cabbage, 0.8 per cent; rice-tobacco, 0.8; and general, 0.8. With the exception of one, all (99.2 per cent) were specialized farms.

Capital investment and ownership. The average capital invested per farm was ₱835.60 (table 1). Of this amount, 64.2 per cent was in land, 20.1 per cent in buildings, and 9.6 per cent in work animals. A very small amount, 2.7 per cent, was invested in tools.

The farm operators owned the various items of farm property, with the exception of land. About 83 per cent of the amount invested in land belonged to the operators. Of the total capital investment, the operators owned 89.1 per cent.

The average investment of each operator according to tenure was: owner, ₱816.92; part-owner, ₱688.92; tenant, ₱193.49. The major portion of the investment of the owner and the part-owner was in land, whereas the investment of the tenant was largely in buildings and work animals.

Size of farms. The farms operated ranged from as low as one-half to as high as seven hectares. About 86 per cent of the farms were less than three hectares, and 58 per cent were less than two hectares. The average area was 1.90 hectares (table 2). Of this area, 69.5 per cent was devoted to crops; 26.3, to pasture and woods; and 4.2 per cent, to farmsteads and home orchards.

The size of farms, according to tenure, was as follows: owner, 1.82 hectares; part-owner, 2.02 hectares; and tenant, 1.40 hectares.

Crops grown and livestock raised. The predominant crop enterprise was rice (table 3). It was grown by all the farmers. The average area per farm was 1.281 hectares. The other important crops grown were corn, sugar cane, and tobacco. A large number of farms raised vegetables, but largely for home use. The area devoted to vegetables was very small, except on one farm where cabbage was grown on a commercial scale. The average farmer had a crop area of 1.953 hectares.

The principal livestock raised were carabaos, cattle, swine, and chickens (table 4). There were very few ducks, sheep, and goats, and no horses in the barrio. The average number per farm of animals commonly raised was: carabao, 1.4 head; cattle, 0.5; hens, 19.6; and swine, 1.4.

Farm receipts and expenses. Receipts came from the sale of field crops, vegetables, fruit, livestock, livestock products, and increase of capital (table 5). The average per farm was ₱104.76, excluding the products used at home. Of this amount, 50.5 per cent was from crops, 23.0 per cent from livestock and livestock products, 15.4 per cent from vegetables and fruit, and 11.26 per cent was due to increase of capital. The farm receipt according to tenure was: owner, ₱77.29; part-owner, ₱135.71; and tenant, ₱131.86. As will be seen later, a large number of farmers sold only a small portion of their products.

The farm expenses averaged ₱75.75 per farm (table 6). Of this amount, 36.8 per cent represented cash expenses; 33.5 per cent, land rent or value of landlord's share of the products; 23.1 per cent, unpaid family labor; and 7.6 per cent, decrease of farm capital. The farm expenses according to tenure were: owner, ₱49.70; part-owner, ₱104.96; and tenant, ₱103.45 (table 6). The owners' relatively small expense was largely due to the fact that they did not have to pay land rent.

Labor income. The labor income averaged –₱23.30 per farm (table 7). There was a very low labor income because a large portion of the products was not sold but used at home. About 70.1 per cent of the farm crops, 45.0 per cent of vegetables and fruits, and 42.8 per cent of livestock and livestock products, or 62.5 per cent of all products, were used at home. Self-sufficient farming was practiced to a considerable extent. In 88.8 per cent of the farms, 50 per cent or more of the products were used at home. Under this condition, which is true in many parts of the Philippines, labor earnings instead of labor income will be a better measure of farming success.

Farm privileges. For family use the farm furnished crops, vegetables, fruit, livestock products, and a house to live in. The average value of these privileges was ₱178.31 per farm (table 8). The largest portion, 69.5 per cent, of this amount consisted of crop products.

The farm privileges, according to tenure, were as follows: owner, ₱171.15; part-owner, ₱190.57; and tenant, ₱106.77.

The value of farm privileges per male adult equivalent was ₱41.66. It was found that the farm privileges per adult decreased as the size of the household increased.

Operator's labor earnings. The operator's labor earnings averaged ₱155.01 per farm (table 9). The labor earnings of the different types of farm operators were: owner, ₱141.48; part-owner, ₱172.77; and tenant, ₱120.22.

Since the labor earnings include the value of farm privileges, it is a better measure of the financial success of the farming business. It was found that the labor earning was directly related to the size of crop area. Those with greater crop area generally obtained higher labor earnings.

Family income. The average farm in the Philippines is so small that the farmer and members of his family must engage in other wage-earning activities. The average family income in the village studied was ₱241.28 (table 10). Of this amount, ₱170.50, or 70.6 per cent, was contributed by the operator, whose income came largely from the farm business. The other members of the family contributed ₱35.62, or 14.8 per cent, half of which represented labor on the farm. Some children of farmers were working in Manila and Hawaii. They sent an average of ₱35.16 per family, or 14.6 per cent of the total family income.

The family income of the different types of operators did not differ markedly. The average was as follows: owner, ₱230.68; part-owner, ₱253.85; and tenant, ₱239.46. These amounts, however, did not include the interest on capital which was charged as expense. This amount, which was greater in the case of owner operators, was available for family expenditures. When this sum was added to family income, the amount available for family living reached ₱293.59 per farm (table 11). The tenant had the lowest, ₱253.82, because of the small interest earned by his limited capital.

The amount available per adult male equivalent was ₱69.22 for owners, ₱70.33 for part-owners, ₱38.23 for tenants, or ₱68.60 for the whole group. The amount for tenants was much lower than that for owners or part-owners.

It was found that the size of the household greatly affected the amount available for each individual. As the size of the household increased, the operator's labor earnings per adult, total family income per adult, and amount available for family living per adult gradually decreased.

Farming practices. The efficiency of agricultural production is dependent upon the farming practices employed. Very few farmers employed modern methods in the growing of rice and corn, the two dominant enterprises in the community. For example, only 6.4 per cent were using manure, and no one applied commercial fertilizers. Pests and diseases were not controlled properly; no farmer used sprays and insecticides.

Horticultural practices that are considered desirable were not generally practiced. Asexual methods of propagation, such as budding, inarching, grafting, and marcotting, were not known. Canning of fruit and making of jelly from fruit were not practiced in the community.

In the raising of livestock, primitive methods were used. No farmer fed balanced rations, used improved stock for upgrading, culled chickens, made cheese, sausage, and salted eggs, nor controlled diseases by quarantine, disinfection, and medication.

Home conditions

Type and size of households. Of the different types of households, that composed of resident family members only comprised 69.1 per cent of the total. The next largest group, 20.6 per cent, was composed of the resident family and relatives.

The number of persons in the household ranged from 1 to 12. The average household contained 1.69 parents, 2.84 children, 0.40 relatives, and 0.10 non-relatives, or a total of 5.03 persons.

Nature and size of dwellings. The majority, or 83.8 per cent, of the houses in the barrio had cogon roofs and bamboo walls and floors. Only 13 (9.5 per cent) had galvanized iron roofs and wooden walls and floors. Eight of these belonged to farm owners and five to part-owners. No house was roofed with nipa.

The floor area per dwelling averaged 48.98 square meters, or 9.74 square meters per person. There were 2.65 rooms per dwelling, or 1.89 persons per room (table 12). About 64.8 per cent of the dwellings had three rooms and 27.7 per cent, two rooms.

The average value of the dwellings was ₱136.08. The value on the basis of tenure was: owner, ₱138.64; part-owner, ₱149.96; tenant, ₱66.67. About 52.2 per cent of the dwellings were valued at less than ₱100.00.

Household facilities and conveniences. The facilities in the farm homes were meagre. There were no electric light, running water in the house, icebox, iron chair, gas stove, indoor toilet, piano, radio, and other modern conveniences. The household facilities consisted mostly of wooden benches (64.7 per cent), bamboo and rattan chairs (56.6 per cent), wooden tables (41.9 per cent), native looms (64.6 per cent), sewing machines (30.9 per cent), wells (44.1 per cent), round-wick lamps (22.1 per cent), and phonographs (6.6 per cent). Because of the existence of a municipal ordinance, 69.1 per cent had outdoor sanitary toilet.

Homeground beautification. Very little had been done by the village dwellers to beautify their yards. The walk leading to the stair was not raised, and there were no hanging plants in the house nor climbing ornamental plants. Only 33.8 per cent had hedges in front of the farmstead, 13.2 per cent had hedges on the side boundaries, 33.8 per cent had flowering plants in the yard, 2.9 per cent had beds of ornamental plants, and 5.1 per cent had plants along the walk leading to the stairs. Many of the farmers (72.8 per cent) had bananas on their farmsteads, and 97.1 per cent had fruit trees.

Community conditions

Educational facilities. There is a school offering complete primary instruction in the barrio. The enrollment in March, 1939, was 142 pupils. Some of the pupils were from the adjacent barrios. The

teaching staff was composed of three teachers. When the survey was conducted, there was an adult education class being attended by 42 persons. The class was held in the school building every Saturday.

School attendance and educational attainment. Of children from 7 to 14 years old, 61.9 per cent were in school, and 38.1 per cent were not. The latter group completed an average of 2.3 grades. Of those from 15 to 24 years old, 95.3 per cent were not in school. The average educational attainment of this group was 3.5 grades. Only one graduated from high school and one from college.

The majority of the children did not go beyond the fourth grade. The distance of the intermediate school, which is located in the poblacion, prevented many from continuing. Poverty was another factor. Early in life, children are generally needed to help in the home or on the farm.

Of individuals 10 years or over, 63.8 per cent could read and 58.5 per cent could write in the dialect, and 42.9 per cent could read and 41.5 per cent could write in English. Only 3.2 per cent could read and 2.0 per cent could write in Spanish.

Reading matter in the home. More than one-half, or 57.5 per cent, of the farm homes did not have books; 34.6 per cent had one book each. Only one, or 0.7 per cent, had six books. The average for the village was 0.6 book per household, excluding school textbooks.

Bannawag, a weekly magazine in the dialect, was found in 69 of the 136 farm homes. Only 17, however, were subscribers. The rest must have borrowed their copies. The number of subscribers in other weekly papers were: *Dangadang,* 5; *Silaw,* 4; *Naimbag a Damag,* 1; and *Liwayway,* 1. Although two dailies in English were found in three farm homes, none subscribed to them. A few other weeklies and magazines were found in several farm homes which were not subscribing to them. No farm journal, farmer's bulletin, or circular was found in farm homes.

There was a dearth of reading matter in the homes in the barrio. Hence, the rural dwellers have very limited contact with the outside world; this makes progress slow and difficult.

Recreational activities. The chief recreational and social activities of parents and older children were visiting neighbors, chatting with friends, playing cards, attending fiestas, weddings, and dances. Very few engaged in such desirable activities as athletics or reading.

Organizational membership. Seventy-two per cent of the households had membership in a local organization, "Sangatalonan", while 28.0 per cent had no membership in any organization. Only two households belonged to a Parent-Teacher Association, and one, to the Boy Scouts.

SUMMARY AND CONCLUSIONS

A survey of farm, home, and community conditions was made in the barrio of Nagbacalan, municipality of Batac, Ilocos Norte. The important findings are the following:

1. Farming was the occupation of 91.9 per cent of the 136 heads of households. The percentage of farm owners was 48.5; part-owners, 41.2; and tenants, 2.2.

2. Rice farm was the most common type, consisting of 97.6 per cent of all farms.

3. The average investment per farm was ₱835.60. Of this amount, 89.1 per cent belonged to the farm operators.

4. The farm receipts averaged ₱104.76; farm expenses, ₱75.75; net farm income, ₱29.01; labor income, –₱23.30; farm privileges, ₱178.31; operator's labor earnings, ₱155.01; operator's total income, ₱170.50; family income, ₱241.28. The amount available for family living was ₱293.59 per household, or ₱68.60 for each adult male equivalent.

5. The farmers generally employed primitive farming methods.

6. Of the six types of households, that consisting of resident family members only composed 69.1 per cent. The average household contained 5.03 persons.

7. The majority, 72.0 per cent, of the male heads of households were born in the barrio. The average length of residence of household heads was 41.2 years in that barrio and 45.6 years in that municipality.

8. The majority, 83.8 per cent, of the houses had cogon roofs and bamboo walls and floors. The average value was ₱136.08. It had 2.65 rooms, or 1.89 persons per room. The floor area was 48.98 square meters, or 9.74 square meters per person.

9. The home conveniences were meagre. No home had electric light or running water. Little attention was given to beautification around the home.

10. Of children from 7 to 14 years old, only 61.9 per cent were in school. Of those from 15 to 24 years old, 95.3 per cent were out of school. The average schooling of this group was 3.5 grades.

11. More than one-half, 57.5 per cent, of the farm homes were without books. Although current literature was found in 75 of the 136 homes, only 26 were getting copies regularly.

12. About 70 per cent belonged to a certain local organization.

LITERATURE CITED

AGBANLOG, ANSELMO. 1930. A study of the standard of living in the towns of Balungao and San Carlos, Pangasinan. The Philippine Agriculturist **18**: 581–803.

DALISAY, AMANDO M. 1938. Factors related to income and cost of production of rice on tenant holdings in Cabiao, Nueva Ecija. The Philippine Agriculturist **26**: 730–756.

HESTER, E. D., AND G. N. MIÑANO. 1921. Tenancy on coconut holdings in the municipality of Looc, Province of Romblon. The Philippine Agriculturist **10**: 145–168.

HESTER, EVETT D., PABLO N. MABBUN, ET AL. 1924. Some economic and social aspects of Philippine rice tenancies. The Philippine Agriculturist **12**: 267–444.

SMITH, C. B., AND M. C. WILSON. 1930. The agricultural extension system of the United States. x + 402 p., 23 fig. New York: John Wiley and Sons, Inc.

VELMONTE, JOSÉ E., O. SUMAGUI, AND P. H. VIRAY. 1934. Living conditions in the farm homes in Mendez Nuñez and Amadeo, Cavite; Mangatarem, Pangasinan; and Camiling, Tarlac. The Philippine Agriculturist **22**: 745–776.

WHEELER, J. T. 1926. Methods in farmer training through participation and placement. xv + 363 p. Atlanta: Turner E. Smith Company.

TABLE 1

Capital investment

ITEMS	AVERAGE	PERCENTAGE
	pesos	
Land	536.78 [a]	64.2
Buildings	167.82	20.1
Tools and equipment	22.12	2.7
Work animals	80.24	9.6
Other livestock	22.62	2.7
Seeds and supplies	6.02	0.7
Total	835 60	100.0

[a] Based on assessed value for taxation purposes, usually lower than the market value.

TABLE 2

Utilization of farm area

	TOTAL AREA	AVERAGE AREA	PERCENTAGE
	hectares	*hectares*	
Crops	165.08	1.32	69.5
Farmstead (including home orchard)	10.01	0.08	4.2
Pasture and woods	62.73	0.50	26.3
Total	237.82	1.90	100.0

TABLE 3

Crops grown

CROPS	NUMBER OF FARMS GROWING	PROPORTION	TOTAL AREA	PROPORTION	AVERAGE AREA PER FARM RAISING	AVERAGE FOR ALL FARMS
		per cent	*hectares*	*per cent*	*hectares*	*hectares*
Rice	125	100.00	160.12	65.56	1.281	1.281
Corn	124	99.20	68.66	28.11	0.554	0.549
Sugar cane	98	78.40	6.53	2.67	0.666	0.052
Tobacco	79	63.20	2.19	0.91	0.028	0.018
Sweet potatoes	42	33.60	0.39	0.16	0.009	0.003
Peanut	49	39.20	1.66	0.68	0.034	0.013
Mungo and cowpea	12	9.60	0.78	0.32	0.065	0.006
Cotton	14	11.20	0.64	0.26	0.046	0.005
Vegetables						
Eggplant	92	73.60	0.47	0.19	0.005	0.003
Tomato	112	89.60	0.88	0.36	0.008	0.007
Patola	31	24.80	0.13	0.05	0.004	0.001
Cabbage	21	16.80	1.10	0.45	0.052	0.009
Ampalaya	66	52.80	0.31	0.13	0.005	0.002
Garlic and onions	52	41.60	0.18	0.07	0.003	0.002
Miscellaneous	23	18.40	0.20	0.08	0.007	0.002
Total	—	—	244.24	100.00	—	1.953

TABLE 4

Livestock raised

LIVESTOCK	NUMBER OF FARMS	PERCENTAGE	NUMBER OF ANIMALS	AVERAGE PER FARM	AVERAGE FOR ALL FARMS
Work animals:					
Carabao	122	97.6	176	1.44	1.41
Cattle	33	26.4	39	1.18	0.31
Other livestock:					
Carabao	2	1.6	4	2.00	0.03
Cattle	14	11.2	24	1.71	0.19
Horses	0	0.0	0	0.00	0.00
Goat	1	0.8	1	1.00	0.01
Sheep	5	4.0	6	1.20	0.05
Swine	119	95.2	182	1.53	1.45
Hens	125	100.0	2,445	19.56	19.56
Ducks	16	12.8	139	8.69	1.11

TABLE 5

Farm receipts [a]

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM	PERCENTAGE
	pesos	*pesos*	*pesos*	*pesos*	
Farm crops	30.64	77.28	86.03	52.87	50.5
Vegetables	8.67	14.64	2.67	11.20	10.7
Fruit	5.62	4.28	1.00	4.90	4.7
Livestock	9.97	12.74	7.67	11.15	10.6
Livestock products	10.50	16.08	12.13	13.04	12.4
Miscellaneous	0.51	0.16	0.00	0.34	0.3
Increase of capital	11.38	10.53	22.36	11.26	10.8
Total	77.29	135.71	131.86	104.76	100.0

[a] Excluding products for home use.

TABLE 6

Farm expenses

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM	PERCENTAGE
	pesos	*pesos*	*pesos*	*pesos*	
Cash expenses	26.24	29.06	10.13	27.12	35.8
Unpaid family labor	15.97	19.32	18.13	17.52	23.1
Decrease of capital	7.49	3.91	0.82	5.73	7.6
Land rent [a]	—	52.67	74.37	25.38	33.5
Total	49.70	104.96	103.45	75.75	100.0

[a] Value of landlord's share.

TABLE 7

Labor income

	OWNER	PART-OWNER	TENANT	ALL FARMS
	pesos	*pesos*	*pesos*	*pesos*
Farm receipts	77.29	135.71	131.86	104.76
Farm expenses	49.70	104.96	103.45	75.75
Net farm income	27.59	30.75	28.41	29.01
Interest at 7 per cent on average capital of farm operator	57.26	48.55	14.36	52.31
Labor income [a]	—29.67	—17.80	+14.05	—23.30

[a] What a farmer "receives for his year's work above interest on his investment and farm expenses and in addition to having a house to live in and farm products to use at home."

TABLE 8

Farm privileges

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM	PERCENTAGE
	pesos	*pesos*	*pesos*	*pesos*	
Farm crops	118.05	133.41	72.86	123.85	69.5
Vegetables and fruit	12.74	14.05	6.52	13.18	7.4
Livestock and livestock products	16.87	19.80	12.84	18.09	10.1
Rental value of dwelling [a]	23.49	23.31	14.55	23.19	13.0
Total	171.15	190.57	106.77	178.31	100.0

[a] Covers depreciation, interest, and cash expenses for taxes and repairs.

TABLE 9

Operator's labor earnings from the farm

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM
	pesos	*pesos*	*pesos*	*pesos*
Farm receipts	77.29	135.71	131.86	104.76
Privileges	171.15	190.57	106.77	178.31
Farm receipts and privileges [a]	248.44	326.28	238.63	283.07
Farm expenses	49.70	104.96	103.45	75.75
Net farm income plus privileges	198.74	221.32	135.18	207.32
Interest on average capital at 7 per cent	57.26	48.55	14.36	52.31
Operator's labor earnings from the farm	141.48	172.77	120.82	155.01

[a] Also called gross farm earnings.

TABLE 10

Family income

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM	PERCENTAGE
	pesos	*pesos*	*pesos*	*pesos*	
Operator's income:					
Income from farm [a]	141.48	172.77	120.82	155.01	64.2
Income from job off farm	17.17	12.00	43.67	15.49	6.4
Total operator's income	158.65	184.77	164.49	170.50	70.6
Income of other members of family					
Income from farm (family labor charged as expense)	15.97	19.32	18.13	17.52	7.3
Income from job off farm	16.96	17.34	56.84	18.10	7.5
Total income of other members	32.93	36.66	74.97	35.62	14.8
Income from other sources					
Money sent by children away from home	39.10	32.42	00.00	35.16	14.6
Total family income	230.68	253.85	239.46	241.28	100.0

[a] Operator's labor earnings.

TABLE 11

Amount available for family living

	OWNER	PART-OWNER	TENANT	AVERAGE PER FARM
Total family income, pesos	230.68	253.46	239.46	241.28
Interest earned by operator's capital, pesos	57.26	48.55	14.36	52.31
Amount available for family living, pesos	287.94	302.40	253.82	293.59
Average size of household (adult male equivalent [a]	4.16	4.30	6.64	4.28
Amount available for each adult male equivalent, pesos	69.22	70.33	38.23	68.60

[a] Computation based on the formula used in the Department of Agricultural Chemistry and taken from: LUSK, GRAHAM. 1928. The element of the science of nutrition. 4th ed., 844 p., 46 fig. Philadelphia: W. B. Saunders Company.

TABLE 12

Size and value of dwellings according to tenure

	OWNER	PART-OWNER	TENANT	NON-FARMER	TOTAL
Number of dwellings .	66	56	3	11	136
Average value in pesos	138.64	149.96	66.67	69.09	136.08
Number of rooms	175	150	8	28	361
Number of rooms per dwelling	2.65	2.68	2.67	2.55	2.65
Number of persons ...	335	294	25	30	684
Number of persons per dwelling	5.08	5.25	8.33	2.73	5.03
Number of persons per room	1.91	1.96	3.12	1.07	1.89
Number of rooms per person	0.52	0.51	0.32	0.93	0.53
Floor area per dwelling in square meters[a]	49.94	51.00	48.10	33.22	48.98
Floor area per person in square meters ...	9.83	9.71	5.77	12.17	9.74

[a] Excludes the "batalan", which is an open platform, usually joining the main house and the kitchen, used for kitchen accessories and for drying farm products, such as rice, corn, and peanuts.

A STUDY OF THE EXHAUST GASES IN RELATION TO CARBURETOR ADJUSTMENTS OF FOUR AND EIGHT CYLINDER AUTOMOTIVE GASOLINE ENGINES [1]

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In carburetor adjustment in a gasoline engine, the customary procedure of using as index the color and smell of the exhaust gases is inaccurate. Even in the hands of experienced mechanics who know almost all types of carburetors, the efficiency of such a method of adjustment is questionable.

Every automobile owner would certainly like to have his car adjusted correctly, either for the maximum fuel economy or for obtaining maximum power. In the Philippines where all the gasoline is imported, the study of the most economical way of utilizing the fuel is very important. It is conceded that a study of the products of combustion is of value in the correct adjustment of carburetors.

Objects of the present work

The objects of the work were: (*a*) to study the exhaust gases of the most powerful, the most economical, and medium adjustment of an engine run at variable speeds and loads; (*b*) to find and compare the fuel consumption, brake horsepower, and brake thermal efficiencies of the three adjustments; and (*c*) to compare the air-fuel ratio for different settings in a four and an eight-cylinder engine.

Time and place of the work

The work was performed in the Department of Agricultural Engineering, College of Agriculture, University of the Philippines, from November, 1934, to January, 1936, with the help of Mr. Marcelino Habacon, an experienced mechanic from the Calamba Sugar Estate.[3]

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[1] Experiment Station contribution No. 1393.

[2] Thesis student who performed most of the experimental work in this study.

[3] The Calamba Sugar Estate detailed Mr. Habacon to the Department of Agricultural Engineering to help in the studies on fuels and lubricants carried on by the department.

MATERIALS AND APPARATUS

Engines used. Three engines, two eight-cylinder and one four-cylinder, were used. The eight-cylinder Ford V-8 engines were mounted, one on a five-passenger Sedan and the other on the bench; the four-cylinder was a Waukesha engine manufactured by the Waukesha Motor Works, Waukesha, Wisconsin, U. S. A.

The following are the specifications of the engines used:

	WAUKESHA ENGINE	FORD
Type or series	XAH	V8 — 112
Age	New	New
Cylinders	4	8
Bore	3⅝"	3-1/16"
Stroke	4½"	3-3/4"
Displacement (cu.in.)	186	221
N.A.C.C. h.p.	21.0	30 (S.A.E.)
Rating (actual h.p. is higher)	(Max. b.h.p. from curve at 2500 r.p.m. = 38)	(Max. b.h.p. at 3400 r.p.m. = 75)
Materials (piston)	Cast iron	Special heat treated aluminum alloy
(head)	Cast iron	Aluminum alloy
Compression ratio	Low compression approx. 4.56 to 1 High compression approx. 6.67 to 1	6.33 to 1
Carburetor make	Zenith (New 90 series)	Special Ford-Detroit lubricator. Downdraft.

The dynamometer used was the same hydraulic dynamometer used by Teodoro.[4] It was manufactured by Heenan & Froude, Limited, Worcester, England. Its size was D. P. × 4 and it could absorb a maximum of 400 horsepower at 2,700 r.p.m. It was provided with a tachometer and a continuous revolution counter directly driven by worm gearing. The r.p.m. of the dynamometer was checked by a hand tachograph which gave readings accurate to 1 r.p.m.

The time of test was recorded by a stop watch which read to 0.2 of a second.

[4] TEODORO, A. L. 1935. Alcohol and alcohol-gasoline blends as fuels for automotive engines: I Performance tests of nearly straight alcohol of different grades using a six-cylinder automobile engine. The Philippine Agriculturist **24**: 180–218. *Charts 1–9; fig. 1.*

Socony gasoline was used in the test. Its specific gravity at 60°F. was 0.7406.

The Orsat apparatus was used to analyze the exhaust gases. It was manufactured by Sargent and Company, Chicago, Illinois. It consisted of a graduated tube or burette surrounded by a water packet to receive the gas and to measure its volume. This burette was connected with a manifold of glass, called a header, to pipettes containing the liquids for absorbing CO_2, O_2, and CO. The pipettes were each a little more than half filled with the absorbing liquid. Distilled water well saturated with CO_2 was usually used for displacement of gases. Carbon dioxide was absorbed in the first pipette, which contained a solution of one part by weight of potassium hydroxide (KOH) in two parts by weight of distilled water. Free oxygen was similarly absorbed by passing through the second pipette containing a mixture of pyrogallic acid and potassium hydroxide. This mixture was prepared by dissolving 5 grams of powdered pyrogallic acid for every 100 cc. of potassium hydroxide as prepared for the first pipette.

The solution for absorbing carbon monoxide was cuprous chloride (Cu_2Cl_2) which was prepared in a glass bottle having a well-fitted glass stopper greased to make it air tight. The cuprous chloride was prepared by filling a container to the top with 150-200 grams copper wire cut in small pieces and pouring over this copper 500 cubic centimeters of commercial hydrochloric acid (specific gravity 1.1, and prepared by mixing one to one by volume of chemically pure acid and distilled water). The solution was allowed to stand for several hours with occasional shaking until it was clear. This cuprous chloride solution was placed in the third pipette. The KOH solution will absorb forty times its volume of CO_2 before renewal is necessary, the pyrogallic acid solution will absorb efficiently only twice its volume of oxygen, and the cuprous chloride only an equal volume of CO. The solutions were frequently renewed during the test.

The common errors in gas analysis are due to leakage so that before any test was made the apparatus was checked for leakage. This checking was done by filling each pipette, and then manipulating the pinchcocks, valves, and leveling bottles so as to bring each solution to a mark in the capillary tube of the pipette. The valves and pinchcocks were then closed and the volume of the gas was observed at atmospheric pressure on the scale of the burette. The leveling bottle was then placed on the top of the case so that the gas in the burette and header was under pressure for about five minutes, after which

the volume was again measured. If there was no leakage, the volume would remain constant.

The gas sample was collected in a sampling aspirator bottle which was connected with the exhaust pipe by a ⅛-inch brass pipe and rubber tubing. The brass pipe was inserted in the exhaust pipe in such a manner that it would face the stream of exhaust gases and thus get a representative sample. The other end of the pipe was connected with rubber tubing to the glass tubing fitted to the rubber cork of the sampling bottle. Another piece of glass tubing fitted to the same cork was connected with a "Y" connection, one branch leading to the header of the Orsat apparatus and the other branch opened or closed to the atmosphere with a pinchcock. Another aspirator bottle was connected with the sampling bottle which forced in or sucked out the contents by water displacement. The distilled water in the sampling bottle was not changed throughout the test.

To make sure that all the gases had been absorbed by each reagent in the order CO_2, O_2, and CO, the process was repeated until readings agreed within 1/10 per cent. With fairly fresh solutions, it took 2 to 3 minutes to absorb CO_2 and O_2 and 5 to 7 minutes to absorb CO.

PROCEDURE OF TEST

Two series of bench tests were made, one with a Waukesha engine and the other with a Ford V-8. The series of tests with the two engines consisted of three adjustments, first at maximum power, second at maximum fuel economy, and lastly at midway between the two adjustments. Adjustments were made in the size of the carburetor main jets. With the Ford V-8, the jet number refers, in thousandths of an inch, to the size of the jet opening.

A series of tests was complete when it included the determination at different speeds of the following:

(1) The brake horsepower

(2) The fuel consumption at full, at three-fourths, at one-half, and at one-fourth loads

(3) The corresponding exhaust analysis at different speeds and loads

The engine was run at speeds 600, 1000, 1400, 1800, and 2200 r.p.m.

The procedure of adjustment of the engine and dynamometer, according to Teodoro (1935), was as follows: Prior to each test great care was taken to lubricate all bearings of the engine and of the dynamometer and its accessories. For a preliminary run, the engine was started, dynamometer adjusted, clutch engaged, and

the load slowly increased. Adjustments of the throttle lever were made until the engine maintained constant running at approximately desired speed. The engine was considered ready for any fuel test when this occurred.

The fuel consumption was determined with the Zenith mileage tester containing 1/10 U. S. gallon. The average of at least five readings, which agreed to fractions of a second, was taken.

The road test was made on the asphalt road from the College to Manila. The speed ranged from 30 to 50 kilometers an hour. A load of the same five passengers was kept throughout the test.

RESULTS OBSERVED AND CALCULATED

Table 1 shows the data and results of the bench test with a Ford V-8 and table 2, the data and results of the bench test with a Waukesha engine.

The following was the result of the road test with a Ford V-8, 5-passenger Sedan:

Jet used	Mileage		
	km./gal.	*mi./gal.*	*km./liter*
Jet 42	33.20	20.63	8.77
Jet 46	32.06	19.92	8.47
Jet 48	29.80	18.52	7.87

These results show that the mileage of 29.80 kilometers per gallon was obtained with jet 48 and the mileage of 33.20 kilometers per gallon was obtained with jet 42.

The percentage of carbon dioxide (CO_2), oxygen (O_2), and carbon monoxide (CO) was determined by direct analysis of the exhaust gases; that of hydrogen (H_2) and methane (CH_4) was computed.

The results of exhaust gas analysis were checked rapidly by Lockwood's "Exhaust Gas Analysis Diagram for Hydrocarbon Fuels." The closer the points of intersection of the values of CO_2, O_2, and CO obtained by analysis, the more accurate the analysis was.

DISCUSSION OF RESULTS

Ford V-8

Brake horsepower. At full load, with the throttle wide open, the power developed with main jet 42, at all test engine speeds, was a little more than with main jets 46 and 48. Acceleration, or pick-up, was attained more quickly and easily with main jets 46 and 48 than with jet 42.

At engine speeds of 2200 and 1800 r.p.m., the horsepower delivered with main jet 46 was a little more than with main jet 48; but at 400 and 600 r.p.m., both delivered the same horsepower. At 1000 r.p.m., the two main jets varied slightly, main jet 48 giving more power.

It was particularly noted that as the size of the main jet used was increased, the power output diminished by fractions of one per cent. This occurrence may be due to the increase in the strength of mixture beyond the point which gave maximum power.

The computed torque in pounds-feet are as follows:

R. P. M.	Jet 42	Jet 46	Jet 48
	lb.-ft.	*lb.-ft.*	*lb.-ft.*
2200	138.96	137.87	131.30
1800	138.94	136.76	135.68
1400	137.87	133.48	133.48
1000	133.51	131.30	132.41
600	129.11	125.78	125.79

The maximum torque and consequently the maximum brake horsepower was obtained at 2200 r.p.m. with main jet 42. The maximum torque and brake horsepower with main jet 46 was observed at 2200 r.p.m. and with main jet 48 at 1800 r.p.m. A difference of less than one-half of one per cent in brake horsepower was observed with main jets 42 and 46 and approximately 5.5 per cent with jets 42 and 48 at 2200 r.p.m.

Fuel consumption. The most economical consumption at full throttle in pounds per brake horsepower hour was:

a. 0.610 with main jet 42 at 2200 r.p.m.
b. 0.563 with main jet 46 at 2200 r.p.m.
c. 0.711 with main jet 48 at 2200 r.p.m.

The maximum fuel consumption, also at full throttle, in pounds per brake horsepower hour was:

a. 0.713 with main jet 42 at 600 r.p.m.
b. 0.726 with main jet 46 at 600 r.p.m.
c. 0.817 with main jet 48 at 600 r.p.m.

At all speeds and loads, the most economical consumption was obtained with main jet 42. The engine speeds for maximum fuel economy were observed when the engine was tested at 1400 to 1800 r.p.m. at ¾, ½, and ¼ loads. The difference in fuel consumption with the three jets increased as the load changed from ¾ to ½ and to ¼.

Brake thermal efficiency. The variations in brake thermal efficiency followed inversely the variations in fuel consumption.

The brake thermal efficiency at all test speeds of the engine was maximum at ¾ load and it was least at ¼ load. The brake thermal efficiency with main jet 42 was higher than with either main jet 46 or main jet 48 at all specific speeds and loads.

The following were indicated:

1. Main jet 42
   a. Maximum B.T.E. = 23.95 per cent at 1400 r.p.m. ¾ load.
   b. Minimum B.T.E. = 10.83 per cent at 600 r.p.m. ¼ load.
2. Main jet 46
   a. Maximum B.T.E. = 22.73 per cent at 2200 r.p.m. ¾ load.
   b. Minimum B.T.E. = 10.09 per cent at 600 r.p.m. ¼ load.
3. Main jet 48
   a. Maximum B.T.E. = 22.65 per cent at 1800 r.p.m. ¾ load.
   b. Minimum B.T.E. = 9.95 per cent at 1000 r.p.m. ¼ load.

Exhaust gas analysis. The exhaust gas analysis with the Orsat apparatus was again proved to be dependable. The air-fuel ratio in pounds per pound at full throttle with main jet 42 at all test engine speeds varied from 16.49:1 to 19.54:1; with main jet 46, from 11.94:1 to 19.49:1; and with main jet 48, from 11.35:1 to 14.33:1. The very rich mixture of gasoline and air which was observed with jet 48 at 2200 r.p.m., particularly, might possibly be the cause for the unsteady engine operation during this test.

The following are clearly indicated by the results of the gas analysis:

1. At specific engine speeds and loads, the mixture strength increased as the size of jets used was made larger.

2. In general, the mixture strength had the tendency to decrease as the engine speed ranged from 2200 to 600 r.p.m. This tendency was also observed when the load was dcereased.

3. With a larger jet opening, jet 48, a high percentage of incompletely burned gas varying from 0 to 7.6 per cent CO, was observed. With main jet 46, there was observed a relatively less amount of unburned fuel. With jet 42, no trace of incompletely burned gas was obtained in the analysis. A relatively higher percentage of oxygen, however, was obtained; this showed that there was too much air in proportion to the fuel. A sign of "pinking" was observed with jet 42, especially at 600 r.p.m.

Road test. The results of the road test indicate a saving of 7.2 per cent mileage with jet 42 compared with jet 48, and 3.4 per cent compared with jet 46.

Waukesha engine

Brake horsepower. With the powerful adjustment of a 2½ turn opening of the carburetor main jet, the maximum brake horsepower that was given by the engine at full throttle varied from 11.75 at 600 r.p.m. to 34.83 brake horsepower at 2200 r.p.m. With the most economical adjustment of 1 turn opening of the carburetor main jet, the brake horsepower at full throttle varied from 11.75 at 600 r.p.m. to 31.16 at 2200 r.p.m. Between the two adjustments, an average difference in the brake horsepower of 9.5 per cent was noted.

With medium adjustment of 1¼ turns of main carburetor jet, the delivered horsepower obtained fell about midway between the two given adjustments.

The computed torque with the three adjustments was:

Engine speed	Powerful	Medium	Economical
r. p. m.	*lb.-ft.*	*lb.-ft.*	*lb.-ft.*
2200	83.15	78.78	74.39
1800	96.29	89.72	93.16
1400	105.04	101.74	93.00
1000	105.04	102.84	100.63
600	102.85	99.53	102.85

Fuel consumption. The fuel consumption at full throttle in pounds per brake horsepower hour with the powerful adjustment varied from 0.811 at 2200 r.p.m. to 0.931 at 600 r.p.m. With the economical adjustment, the fuel consumption at full throttle in the same unit varied from 0.604 at 1400 r.p.m. to 0.689 at 2200 r.p.m. With the economical adjustment, an average possible saving of about 23.7 per cent was obtained. At specific engine loads and speeds, the fuel consumption with the powerful adjustment was larger by about 20 to 25 per cent than with the economical adjustment.

Brake thermal efficiency. The brake thermal efficiencies at variable loads and speeds followed inversely the variations in fuel consumption. The brake thermal efficiencies with the economical adjustment were, in all cases compared, higher than with either the medium or powerful adjustments.

The following were indicated:

1. Economical adjustment
   - *a*. Maximum B.T.E. = 20.78 per cent at 1400 r.p.m., full load.
   - *b*. Minimum B.T.E. = 10.00 per cent at 2200 r.p.m., ¼ load.

2. Medium adjustment
   a. Maximum B.T.E. = 19.34 per cent at 1800 r.p.m., ¾ load.
   b. Minimum B.T.E. = 9.77 per cent at 2200 r.p.m., ¼ load.
3. Powerful adjustment
   a. Maximum B.T.E. = 16.45 per cent at 1400 r.p.m., ¾ load.
   b. Minimum B.T.E. = 8.50 per cent at 2200 r.p.m., ¼ load.

Exhaust gas analysis. The results of the exhaust gas analysis showed that the general tendency was that the greater the opening of the main jet, the richer was the mixture observed. The mixture proportion of fuel and air with the powerful adjustment varied from 11.10 pounds of air to 1 pound of gasoline at 1000 r.p.m. to 11.12 pounds of air to 1 pound of gasoline at 600 r.p.m. The average of mixture proportions gave 12.83:1 air to fuel. With the economical adjustment, the air-fuel ratio varied from 16.6 pounds of air to 1 pound of gasoline at 1000 r.p.m. to 18.39 pounds of air to 1 pound gasoline at 600 r.p.m. The average with this adjustment was 17.51:1 air to fuel.

One very important thing noted in this analysis was that the air-fuel ratios at 600 r.p.m. in nearly all loads and adjustments were beyond the limits of combustibility but within the limits of inflammability of gasoline. It was thought that this might be true because the mixture, owing to the missing of firing at this speed, would pass out unburned leaving a very high percentage of oxygen in the exhaust gas; consequently the air-fuel ratio would be very high. The operation was very unsteady also.

The presence of a high percentage of carbon monoxide in the exhaust gas was again observed when the carburetor main jet was wider. The relative percentage of carbon monoxide was less at medium adjustment and absent at the most economical adjustment.

SUMMARY AND CONCLUSIONS

The use of different sizes of jet openings shows the following:

1. The fuel consumption in pounds per brake horsepower hour is greater with the large jet opening than with the small.

2. A corresponding increase in power up to a certain point was observed with the larger jet opening.

3. The relative brake thermal efficiency at specific speeds and loads is smaller with the large jet opening than with the small.

4. The acceleration, or pick-up, is quicker and easier with the large jet opening than with the small.

From the results of gas analysis, the following can be deduced:

1. There is a tendency for the fuel-air mixture to vary towards the lean when the load and speed decreases.

2. With the larger jet opening, the air-fuel mixture at all speeds and loads is richer. The presence of a great amount of unburned gas is noticeable.

3. The mixture of air and fuel when the small jet opening is used is lean and the presence of a high percentage of oxygen is noticeable, showing that there is an excess of air.

TABLE 1

Data and results of bench test with Ford V-8, with different sizes of main jet. (Socony gasoline)

Group 1. (Jet 42)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
63.5	2200	58.21	35.52	0.610	20.57	Cooling water	13.0	2.2	0	0	0	84.8	16.70
63.5	1800	47.62	29.46	0.619	20.27	temperature =	13.2	1.8	0	0	0	85.0	16.50
63.0	1400	36.75	23.15	0.630	19.92	170°F.	12.4	3.2	0	0	0	84.4	17.60
61.0	1000	25.42	16.82	0.661	18.98	Barometric read-	12.0	3.6	0	0	0	84.4	18.00
59.0	600	14.75	10.52	0.713	17.60	ing = 29.73 in. Hg.	11.0	4.9	0	0	0	84.1	19.50
						Room temperature = 92°F.							
						Three-fourths load							
47.62	2200	43.72	24.22	0.554	22.66	Cooling water	13.4	1.6	0	0	0	85.0	16.30
47.62	1800	35.78	19.00	0.531	23.63	temperature =	13.0	2.2	0	0	0	84.8	16.70
47.25	1400	27.59	14.45	0.524	23.95	170°F.	12.6	2.7	0	0	0	84.7	17.20
45.75	1000	19.08	10.67	0.560	22.41	Barometric read-	11.7	3.9	0	0	0	84.4	18.40
44.25	600	11.08	6.63	0.598	20.98	ing = 29.77 in. Hg.	11.2	4.6	0	0	0	84.2	19.20
						Room temperature = 92°F.							

TABLE 1 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
31.75	2200	29.15	17.83	0.612	20.50	Cooling water	13.2	1.8	0	0	0	85.0	16.50
31.75	1800	23.85	14.68	0.616	20.37	temperature =	12.8	2.6	0	0	0	84.6	17.00
31.5	1400	18.37	11.32	0.616	20.37	168°F.	11.9	3.7	0	0	0	84.4	18.20
30.5	1000	12.71	8.42	0.663	18.92	Barometric read-	11.6	4.2	0	0	0	84.2	18.60
29.5	600	7.38	5.39	0.730	17.19	ing = 29.71 in.	10.5	5.6	0	0	0	83.9	20.40
						Hg.							
						Room tempera-							
						ture = 90.5°F.							
						One-fourth load							
15.87	2200	14.57	13.14	0.905	13.87	Cooling water	13.0	2.2	0	0	0	84.8	16.75
15.87	1800	11.93	10.68	0.896	14.00	temperature =	13.2	1.8	0	0	0	85.0	16.50
15.75	1400	9.22	8.35	0.905	13.87	165°F.	12.7	2.6	0	0	0	84.7	17.10
15.25	1000	6.37	6.03	0.947	13.25	Barometric read-	12.0	3.6	0	0	0	84.4	18.00
14.75	600	3.70	4.29	1.159	10.83	ing = 29.8 in.	10.2	6.0	0	0	0	83.8	21.00
						Hg.							
						Room tempera-							
						ture = 86°F.							

TABLE 1 (continued)

Group 2 (Jet 46)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
63.00	2200	57.75	37.53	0.653	19.22	Cooling water	10.2	0.3	6.2	2.4	0.8	80.1	11.9
62.50	1800	46.87	30.93	0.659	19.04	temperature =	10.8	0.5	4.9	1.9	0.6	81.3	12.7
61.00	1400	35.58	23.84	0.669	18.75	175°F.	11.2	0.6	4.2	1.6	0.5	81.9	13.1
60.00	1000	25.00	17.51	0.700	17.93	Barometric read-	11.4	0.7	3.8	1.4	0.5	82.2	13.4
57.50	600	14.37	10.36	0.726	17.28	ing = 29.78 in. Hg.	8.6	6.5	1.9	0.7	0.2	82.0	19.5
						Room temperature = 94°F.							
						Three-fourths load							
47.25	2200	43.31	23.95	0.552	22.73	Cooling water	13.0	2.2	0	0	0	84.8	16.7
46.87	1800	34.65	19.17	0.552	22.73	temperature =	13.4	1.6	0	0	0	85.0	16.3
45.75	1400	26.68	15.03	0.563	22.29	160°F.	13.8	1.0	0	0	0	85.2	15.8
45.00	1000	18.75	11.09	0.591	21.23	Barometric read-	13.5	1.4	0	0	0	85.1	16.1
41.12	600	10.78	6.64	0.615	20.40	ing = 29.79 in. Hg.	10.0	6.3	0	0	0	83.7	21.4
						Room temperature = 84°F.							

TABLE 1 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSE-POWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
31.50	2200	28.87	18.50	0.640	19.61	Cooling water	13.2	1.8	0	0	0	85.0	16.5
31.25	1800	23.43	14.93	0.635	19.76	temperature =	13.5	1.5	0	0	0	85.0	16.2
30.50	1400	17.79	12.01	0.675	18.59	172° F.	13.7	1.1	0	0	0	85.2	15.9
30.00	1000	12.50	9.05	0.722	17.38	Barometric read-	13.5	1.6	0	0	0	84.9	16.2
28.75	600	7.18	5.63	0.783	16.02	ing = 29.74 in. Hg.	10.8	3.6	1.6	0.6	0.2	83.2	16.8
						Room temperature = 92.5° F.							
						One-fourth load							
15.75	2200	14.43	13.41	0.928	13.52	Cooling water	14.2	0	0.4	0.2	0.1	85.2	14.9
15.62	1800	12.22	10.28	0.917	13.68	temperature =	13.5	0.7	0.8	0.3	0.1	84.6	15.1
15.25	1400	8.89	8.52	0.957	13.11	160° F.	13.4	1.0	0.5	0.2	0.1	84.8	15.5
15.00	1000	6.25	6.13	0.980	12.80	Barometric read-	13.5	1.3	0.2	0.1	0.0	84.9	15.9
14.37	600	3.59	4.33	1.250	10.04	ing = 29.73 in. Hg.	10.6	4.4	1.2	0.5	0.2	83.2	17.8
						Room temperature = 92° F.							

TABLE 1 (continued)

Group 3 (Jet 48)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
58–62	2200	55.00	41.84	0.761	16.49	Cooling water	9.2	0.2	7.6	2.9	1.0	79.1	11.3
62.00	1800	46.50	33.07	0.711	17.65	temperature =	9.3	0.6	7.0	2.7	0.9	79.7	11.8
61.00	1400	35.58	25.36	0.713	17.60	167°F.	9.8	0.6	6.5	2.5	0.8	79.8	11.9
60.50	1000	25.21	19.08	0.757	16.58	Barometric read-	10.2	0.4	6.0	2.3	0.8	80.3	12.1
57.50	600	14.37	11.72	0.816	15.38	ing = 29.79 in.	8.6	3.5	5.3	2.0	0.7	79.9	14.3
						Hg.							
						Room tempera-							
						ture = 87°F.							
						Three-fourths load							
46.50	2200	42.62	25.49	0.598	20.98	Cooling water	14.1	0.5	0	0	0	85.4	15.5
46.50	1800	34.87	19.33	0.554	22.65	temperature =	14.0	0.7	0	0	0	85.3	15.6
45.75	1400	26.68	15.05	0.567	22.13	170°F.	13.8	0.9	0	0	0	85.3	15.8
45.37	1000	18.91	11.34	0.600	20.91	Barometric read-	13.2	1.8	0	0	0	85.0	16.5
43.12	600	10.78	7.03	0.652	19.25	ing = 29.68 in.	11.0	4.0	1.0	0.4	0.1	83.5	17.6
						Hg.							
						Room tempera-							
						ture = 88°F.							

TABLE 1 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
31.00	2200	28.41	21.32	0.750	16.73	Cooling water	9.7	1.1	5.9	2.2	0.8	80.3	12.5
31.00	1800	23.25	16.93	0.728	17.24	temperature =	10.8	0.7	4.8	1.8	0.6	81.3	12.8
30.50	1400	17.79	13.83	0.777	16.15	163°F.	11.8	0.6	3.5	1.3	0.5	82.3	13.4
30.25	1000	12.60	10.40	0.825	15.21	Barometric read-	13.2	0.4	1.6	0.6	0.2	84.0	14.4
28.75	600	7.18	5.92	0.830	15.12	ing = 29.69 in.	13.6	0.2	0.9	0.3	0.1	85.2	14.8
						Hg.							
						Room tempera-							
						ture = 87°F.							
						One-fourth load							
15.50	2200	14.20	15.17	1.068	11.75	Cooling water	11.6	0.5	4.0	1.5	0.5	81.9	13.0
15.50	1800	11.62	13.35	1.148	10.93	temperature =	11.2	0.4	4.6	1.7	0.6	81.5	12.7
15.25	1400	8.89	10.98	1.234	10.17	170°F.	11.6	0.6	4.5	1.7	0.6	81.6	13.0
15.12	1000	6.30	7.94	1.261	9.95	Barometric read-	10.5	1.4	4.5	1.7	0.6	81.3	13.3
14.37	600	3.59	4.18	1.172	10.71	ing = 29.69 in.	10.3	2.2	3.8	1.4	0.5	81.8	14.3
						Hg.							
						Room tempera-							
						ture = 85.5°F.							

TABLE 2

Data and results of bench test with Waukesha engine, type XAH, using low compression head. (Socony gasoline)
Group 1. (One turn of main carburetor jet)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE N_2	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4		
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
34.00	2200	31.16	21.47	0.689	18.21	Cooling water	12.0	3.6	0	0	0	84.4	18.00
38.00	1800	28.50	17.97	0.631	19.89	temperature =	12.5	3.0	0	0	0	84.5	17.40
42.50	1400	24.79	14.98	0.604	20.78	162°F.	12.7	2.6	0	0	0	84.7	17.10
46.00	1000	19.16	12.19	0.636	19.73	Barometric read-	12.6	2.2	0.4	0.2	0.0	84.6	16.60
47.00	600	11.75	8.01	0.681	18.43	ing = 29.86 in.	11.0	4.5	0.6	0.2	0.1	83.6	18.40
						Hg.							
						Room tempera-							
						ture = 88°F.							
						Three-fourths load							
28.50	2200	26.11	17.91	0.686	18.29	Cooling water	11.7	3.9	0	0	0	84.4	18.40
33.00	1800	24.75	15.96	0.645	19.46	temperature =	11.9	3.7	0	0	0	84.4	18.20
36.00	1400	21.00	12.81	0.610	20.57	161°F.	12.2	3.2	0	0	0	84.6	17.70
36.00	1000	15.00	9.53	0.635	19.76	Barometric read-	10.5	5.6	0	0	0	83.9	20.40
35.25	600	8.80	5.82	0.661	18.98	ing = 29.89 in.	7.6	9.8	0	0	0	82.6	27.80
						Hg.							
						Room tempera-							
						ture = 91°F.							

TABLE 2 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
19.00	2200	17.41	14.52	0.834	15.05	Cooling water	11.2	4.6	0	0	0	84.2	19.20
22.00	1800	16.50	12.51	0.758	16.56	temperature =	11.6	4.2	0	0	0	84.2	18.60
24.00	1400	14.00	10.07	0.718	17.48	164°F.	11.9	3.7	0	0	0	84.4	18.20
24.00	1000	10.00	7.33	0.733	17.12	Barometric read	9.2	7.6	0	0	0	83.2	23.20
23.50	600	5.87	4.61	0.785	15.99	ing = 29.93 in. Hg.	7.2	10.4	0	0	0	82.4	29.30
						Room temperature = 86°F.							
						One-fourth load							
9.50	2200	8.70	10.91	1.255	10.00	Cooling water	11.6	4.2	0	0	0	84.2	18.60
11.00	1800	8.25	9.03	1.095	11.46	temperature =	11.9	3.7	0	0	0	84.4	18.20
12.00	1400	7.00	7.42	1.059	11.85	168°F.	12.6	2.7	0	0	0	84.7	17.20
12.00	1000	5.00	5.45	1.091	11.50	Barometric read	7.2	10.4	0	0	0	82.4	29.30
11.75	600	2.93	3.31	1.129	11.11	ing = 29.93 in. Hg.	6.8	11.0	0	0	0	82.2	31.00
						Room temperature = 91°F.							

TABLE 2 (continued)

Group 2. (One and one-fourth turns of main carburetor jet)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
36.00	2200	33.00	23.56	0.714	17.56	Cooling water	12.8	1.2	1.3	0.5	0.2	84.0	15.1
41.00	1800	30.75	21.01	0.683	18.37	temperature =	12.4	0.6	2.6	1.0	0.3	84.1	13.9
46.50	1400	27.12	18.32	0.675	18.59	164°F.	11.6	0.4	4.0	1.5	0.5	82.0	13.0
47.00	1000	19.58	14.11	0.721	17.40	Barometric read-	10.7	1.0	4.6	1.7	0.6	81.4	13.1
45.50	600	11.37	8.88	0.781	16.07	ing = 29.77 in. Hg.	5.6	10.0	2.6	1.0	0.3	81.5	23.9
						Room temperature = 91°F.							
						Three-fourths load							
28.50	2200	26.11	18.63	0.713	17.60	Cooling water	13.8	1.0	0	0	0	85.2	15.8
33.00	1800	24.75	16.28	0.658	19.07	temperature =	13.7	1.1	0	0	0	85.2	15.9
36.00	1400	21.00	13.63	0.649	19.34	162°F.	13.4	1.5	0	0	0	85.1	16.2
36.00	1000	15.00	9.86	0.657	19.09	Barometric read-	10.5	5.8	0	0	0	83.7	20.5
35.25	600	8.80	6.38	0.725	17.31	ing = 29.84 in. Hg.	8.0	8.9	0.5	0.2	0.1	82.3	24.7
						Room temperature = 85°F.							

TABLE 2 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSE-POWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
19.00	2200	17.41	14.65	0.841	14.92	Cooling water	13.4	1.2	0.4	0.2	0.0	84.8	15.7
22.00	1800	16.50	12.92	0.783	16.03	temperature =	13.4	1.5	0	0	0	85.1	16.2
24.00	1400	14.00	10.58	0.756	16.60	168°F.	12.7	2.6	0	0	0	84.7	17.1
24.00	1000	10.00	7.80	0.780	16.09	Barometric read-	9.6	6.6	0.4	0.2	0.0	83.2	21.2
23.50	600	5.87	5.21	0.888	14.13	ing = 29.81 in.	7.5	9.9	0.4	0.2	0.0	82.0	26.7
						Hg.							
						Room tempera-							
						ture = 85°F.							
						One-fourth load							
9.50	2200	8.70	11.18	1.285	9.77	Cooling water	13.4	1.3	0.2	0.1	0.0	85.0	15.9
11.00	1800	8.25	9.37	1.136	11.05	temperature =	13.5	0.9	0.6	0.2	0.1	84.7	15.1
12.00	1400	7.00	7.81	1.116	11.24	166°F.	13.0	1.6	0.4	0.2	0.0	84.8	15.9
12.00	1000	5.00	5.69	1.139	11.02	Barometric read-	8.9	7.5	0.4	0.2	0.0	83.0	22.7
11.75	600	2.93	3.66	1.249	10.05	ing = 29.87 in.	6.5	10.9	0.4	0.2	0.0	82.0	30.0
						Hg.							
						Room tempera-							
						ture = 82°F.							

TABLE 2 (continued)

Group 2. (One and one-fourth turns of main carburetor jet)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						Full load							
38.00	2200	34.83	28.14	0.811	15.47	Cooling water	9.8	1.5	5.5	2.1	0.7	80.4	12.80
44.00	1800	33.00	26.74	0.810	15.49	temperature =	9.6	0.4	6.8	2.6	0.9	79.7	11.70
48.00	1400	28.00	19.33	0.819	15.32	167°F.	9.4	0.2	7.4	2.8	1.0	79.2	11.40
48.00	1000	20.00	17.54	0.877	14.31	Barometric read	8.2	0.8	8.7	3.3	1.1	77.9	11.20
47.00	600	11.75	10.93	0.931	13.48	ing = 29.86 in.	5.8	7.4	5.3	2.0	0.7	78.8	17.10
						Hg.							
						Room tempera-							
						ture = 85°F.							
						Three-fourths load							
28.50	2200	26.11	21.96	0.841	14.92	Cooling water	11.2	1.6	3.4	1.3	0.4	82.1	14.00
33.00	1800	24.75	19.38	0.783	16.03	temperature =	11.5	0.2	4.3	1.6	0.6	81.7	12.80
36.00	1400	21.00	16.01	0.763	16.45	166°F.	11.3	0.9	3.8	1.4	0.5	82.1	13.50
36.00	1000	15.00	11.63	0.776	16.17	Barometric read	8.5	5.6	3.3	1.3	0.4	80.9	17.00
32.25	600	8.80	7.62	0.865	14.51	ing = 29.77 in.	5.6	9.6	3.3	1.3	0.4	79.8	21.94
						Hg.							
						Room tempera-							
						ture = 88°F.							

TABLE 2 (continued)

DYNAMOMETER LOAD	ENGINE SPEED	HORSEPOWER	FUEL CONSUMPTION		BRAKE THERMAL EFFICIENCY	REMARKS	ORSAT GAS ANALYSIS			CALCULATED		BY DIFFERENCE	AIR-FUEL RATIO BY DIAGRAM
							CO_2	O_2	CO	H_2	CH_4	N_2	
pounds	*r.p.m.*	*b.h.p.*	*lb./hr.*	*lb./b.h.p.-hr.*	*per cent*		*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*per cent*	*lb./lb.*
						One-half load							
19.00	2200	17.41	17.47	1.003	12.51	Cooling water	10.7	2.2	3.4	1.3	0.4	82.0	14.40
22.00	1800	16.50	14.71	0.891	14.08	temperature =	11.8	0.2	4.0	1.5	0.5	82.0	12.90
21.00	1400	14.00	12.32	0.857	14.64	160°F.	11.0	1.4	3.7	1.4	0.5	82.0	13.80
24.00	1000	10.00	9.15	0.915	13.71	Barometric read	7.9	6.7	2.9	1.1	0.4	81.0	18.60
23.50	600	5.87	5.67	0.965	13.00	ing = 29.75 in	5.2	10.4	2.4	0.9	0.3	80.8	25.50
						Hg.							
						Room temperature = 90°F.							
						One-fourth load							
9.50	2200	8.70	12.48	1.476	8.50	Cooling water	12.0	0.8	2.9	1.1	0.4	82.8	13.90
11.00	1800	8.25	10.51	1.274	9.85	temperature =	11.6	0.0	4.3	1.6	0.6	81.9	12.70
12.00	1400	7.00	8.53	1.219	10.29	160°F.	11.5	0.9	3.7	1.4	0.5	82.0	13.40
12.00	1000	5.00	6.16	1.232	10.19	Barometric read	10.5	2.5	3.6	1.4	0.5	81.8	14.50
11.75	600	2.93	3.61	1.233	10.18	ing = 29.87 in.	6.4	10.3	1.2	0.5	0.3	81.4	26.30
						Hg.							
						Room temperature = 85°F.							

SEPTORIA LEAF SPOT OF TOMATO [1]

DOMINGO M. ENDRINAL AND M. S. CELINO
Of the Department of Plant Pathology

WITH THREE TEXT FIGURES

THE DISEASE

History, distribution, and economic importance

The Septoria leaf spot of tomato is an old disease. It was reported as early as 1882 in Argentina, 1888 in Italy, 1896 in the United States, and 1902 in Australia (McAlpine, 1903). The same disease was very destructive in France (Delacroix, 1905) and in Gloucestershire, England (Güssow, 1908, and Long, 1913) where it destroyed a crop of outdoor tomatoes in 1907 and again in 1908. According to Pritchard and Porte (1924), the disease caused an annual loss of about 250,000 tons of tomatoes in the United States. Briant (1932) reported Septoria leaf spot as fairly common in Trinidad, although it rarely causes much defoliation.

Long (1913), Levin (1916), Taubenhaus (1918), and Briant (1932) recommended the use of Bordeaux mixture in various concentrations and in different ways of application in the control of the Septoria leaf spot. The same authors suggested the control of the disease by sanitary measures. Long (1913) advised the use of seeds from uninfected areas only and the application of lime around young plants at the time of planting. Crop rotation and the planting of clean seedlings in clean soil are recommended by Levin (1916). Pritchard and Porte (1924) recommend crop rotation and destruction of trash that is diseased. Briant (1932) suggests early planting to escape disease incidence. He further recommends the planting of tomato during the dry season, as the disease is severe under humid conditions.

The disease has not heretofore been reported in the Philippines. On October 5, 1939, the disease was collected from the cultures of the Department of Plant Pathology where one hundred per cent of

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[1] Experiment Station contribution No. 1394. Prepared in the Department of Plant Pathology under the direction of Associate Professor G. O. Ocfemia.

the plants were infected with varying degrees of severity. Owing to severe infection, many of the leaves dried out, and a number of the plants died.

Symptoms

The disease starts on any portion of the leaves of tomato. It usually begins on the older lower leaves and spreads toward the

Fig. 1. A leaf of tomato with the characteristic spot caused by *Septoria lycopersici* Speg. under field conditions. Photograph by the Photographic Division, College of Agriculture.

apex of the stem and gradually infects all the leaves with the exception of a small tuft at the apex. When young, the disease appears as minute dark spots about the size of the head of a pin. The spots gradually increase in size and take on a brown to grayish color (fig. 1). Old spots have dark colored borders and light colored centers. They measure from two to three millimeters in diameter. Very often

neighboring spots coalesce and form larger ones. As the diseased areas dry out, the tissues shrink and various forms of distortion follow. Small, black pycnidia of the fungus are produced on the diseased areas. The pycnidia are formed subepidermally, but later they

Fig. 2. A portion of a stem of tomato with spots caused by *Septoria lycopersici* Speg. Photograph by the Photographic Division, College of Agriculture.

become visible on the upper surface of the leaf. From one to several pycnidia may be produced on one spot.

On tomato stems, the disease appears as small, slightly elongate, dark sunken spots (fig. 2). These spots are not so clearly defined as those on the leaves. The injury to the stem is often not so serious as that on the leaves.

The disease produces on the calyx of the flower small spots intermediate in form between those on the leaves and stems.

CAUSAL ORGANISM

Morphology

Mycelium. Young and old hyphae are frequently septate, hyaline to light brown, thin-walled, variable in size, and vacuolate (fig. 3a).

Measurements of 175 cells of the hyphae show that they vary from 8.7 to 22.7 μ in length and from 2.1 to 3.5 μ in width. The average is 15.9 $\times$ 3.1 μ.

Pycnidia. The pycnidia are formed on diseased leaves and stems of tomato. They are produced in abundance on culture media and sterilized plant substrates. The pycnidium consists of a hollow, globose body, without distinct ostiole. The wall of the pycnidia breaks easily under the cover glass, and the pycnospores are freed. The pycnidia are 300 to 750 μ in width; the average of 150 pycnidia is 554.7 μ. The pycnidia produced on the host are generally much smaller. They are 30 to 175 μ in width; the average of 150 pycnidia is 65.5 μ. Pycnospores are produced in great numbers inside the pycnidium. At maturity the pycnidial wall breaks, and the pycnospores are liberated.

Pycnospores. The pycnospores are filiform, zero to nine-septate, hyaline, and have granular contents (fig. 3b). They are 28.0 to 119.0 μ in length and 2.1 to 3.8 μ in width; the average size of 250 pycnospores is 67.0 $\times$ 3.2 μ.

The pycnospores germinate readily. At germination the pycnospores elongate and swell to almost twice their natural size (fig. 3c). After 36 hours, from 1 to 8 germ tubes may be formed from each pycnospore (fig. 3d).

Growth on media and substrates

Oatmeal agar. The fungus grew slowly and produced scanty mycelium. Pycnidia were formed, and these became visible after 14 days. The pycnospores were exuded from the pycnidia after 21 days.

Corn meal agar. Scattered mycelial growths with small black submerged pycnidia were formed after 8 days. The fungous growth was chaetura black,[2] with the medium assuming the same color.

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[2] RIDGWAY, R. 1912. Color standards and color nomenclature. 43 p., *53 colored pl.; 1115 named colors.* Washington, D. C.

Tomato-decoction agar. The growth on this medium was slow. Minute, black, and submerged pycnidia were formed after 8 days. Marked increase in growth was noted after 21 days. The growth was chaetura black with the medium assuming the same color.

Potato-dextrose agar. The growth was similar to that on tomato-decoction agar. The fungus grew slowly. A light increase in

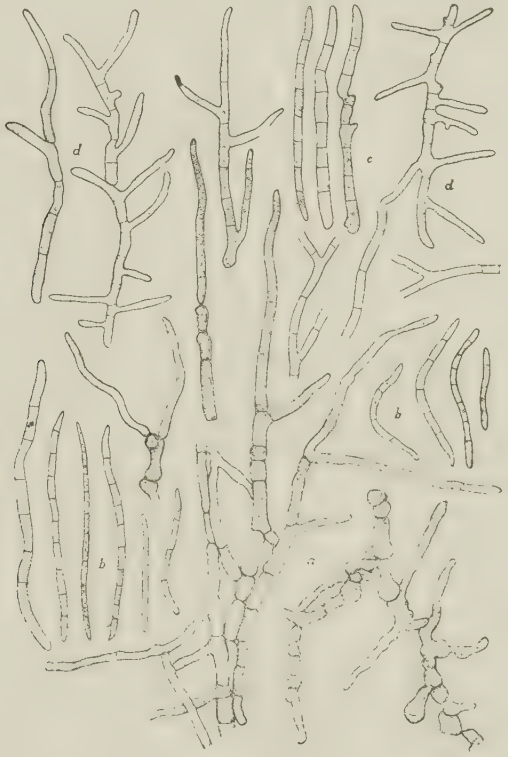

Fig. 3. *Septoria lycopersici* Speg.: (a) mycelium, (b) pycnospores, (c) germinating pycnospores, and (d) pycnospores with several germ tubes. All drawings were made with the aid of a camera lucida. About × 416.

growth was noted after 8 days. Stromata and submerged pycnidia with whitish aërial mycelium were formed.

Water agar. Water agar was the poorest medium for this fungus. The color of the growth was wood brown with very scanty, dirty white mycelium. Few submerged pycnidia were formed.

Steamed oatmeal. The fungus showed a poor growth of mycelium which remained scanty even after one month. No stroma was formed, but pycnidia appeared on the surface of the substrate. Submerged pycnidia were noted after 8 days. The growth was chaetura black. White spore masses were exuded from the pycnidia after 14 days.

Steamed corn meal. The growth was slow. No stroma was formed, but black submerged pycnidia were noted after 8 days, and white spore masses were exuded after 14 days.

Steamed rice. The fungus grew slowly; the medium turned dark with indefinite scattered brownish fungous growths. Submerged pycnidia appeared after 8 days. The color of the fungous growths changed from brownish to chaetura black. Thin stromata were formed after 21 days.

Sterilized green cowpea pods. There was very little fungous development after 3 days. The mycelium was scanty, and no change in the color of the substrate was noted. Increased growth was noted after 8 days. Black submerged pycnidia, about one millimeter in diameter, were formed. Avellanous masses of spores were exuded from the pycnidia after 21 days.

Sterilized Kentucky beans. The fungus grew slowly and produced scanty hyphal threads after 3 days. A slight increase in growth was noted after 8 days. Stromata with whitish aërial mycelium were formed. The pycnidia were grayish black.

String beans. As on Kentucky beans, very little growth was noted after 3 days. The mycelium was scanty, and no change in color of the substrate was noted. A slight increase in growth was noted after 8 days. Submerged pycnidia were formed.

Sterilized gabi tuber. Very little growth was noted after 3 days, but an increase in growth was shown after 8 days. The growths were about two millimeters in diameter with distinct black and submerged pycnidia after 8 days.

Sterilized sweet potato plugs. As in sterilized gabi plugs, very little growth was noted after 3 days. The mycelium was scanty, and there was no change in color of the substrate. The growths were about two millimeters in diameter with distinct black and submerged pycnidia after 8 days.

Sterilized tomato leaf. Aërial growth was abundant after 3 days and more so after 8 days. A marked increase in growth was noted after 14 days. Pycnidia were formed on the edge of the mat of mycelium.

The results from growing the tomato Septoria on various media showed that, of the media tried, potato-dextrose agar was the best, and water agar, the poorest. A fairly good growth was produced on oatmeal agar and on tomato-decoction agar. Of the sterilized plant substrates, sweet potato cubes, carrot cubes, Kentucky beans, eggplant fruit cubes, sliced tomato fruit, and sliced pepper fruit were fairly good. Gabi, tomato stems, and tomato leaf were poor. A fair growth was produced on cowpea, string beans, pechay petiole, and potato.

Only the *Septoria* stage of the fungus was noted on all culture media and on the different substrates.

Growth of the fungus on potato-dextrose agar of different hydrogen-ion concentrations

The fungus was grown on potato-dextrose agar to which were added varying amounts of sterilized hydrochloric acid and sodium hydroxide for the purpose of varying the hydrogen-ion concentrations of the media. To the dissolved potato-dextrose agar in test tubes, different amounts of 0.04216 N HCl or 0.03577 N NaOH were added, and the pH of the media were adjusted by the colorimetric method with a La Motte Universal Outfit.

Potato-dextrose agar slants with reactions ranging from pH 3.8 to pH 8.4 were inoculated with the mycelium. Triplicate cultures representing each pH were prepared. The cultures were placed in a chamber with a temperature of about 19° to 20°C.

The rate of growth and the development of the hyphae and stromata increased with the gradual decrease of acidity of the media. The best growth of the fungus was noted on agar with pH of from 5.6 to 8.4.

Taxonomy

Spegazzini described *Septoria lycopersici* on tomato in 1882 (Güssow, 1909). This fungus was for some time called *S. lycopersici* var. *europaea* Briosi and Cavara in England (Long, 1913). Levin (1916) described the fungus as producing pycnospores which are filiform and hyaline with 3 to 9 septa and 60-120 × 2-4 μ. The mycelium consists of frequently septate, vacuolate threads, 2 to 3 μ in

width. The pycnidia are hollow, globose bodies, 100 to 375 μ in diameter. According to Stevens (1925) the pycnospores are 70-100 $\times$ 3.3 μ. This author did not give the size of the pycnidia. Evidently Stevens' determination was based on the size of the pycnospores only.

The writers found that the pycnospores of the tomato *Septoria* in the Philippines are 28.0-119.0 $\times$ 2.1-3.8 μ; the average is 66.9 $\times$ 3.2 μ. The pycnidia produced in cultures are 300-750 μ in diameter; the average is 554.7 μ.

The cells of the hyphae are 8.7-22.7 $\times$ 2.1-3.5 μ; the average is 15.9 $\times$ 3.1 μ.

The pycnidia of the Philippine *Septoria* on tomato are wider than those reported by Levin (1916) for *S. lycopersici.* The pycnospores of the Philippine species, however, agree very closely with those of Levin (1916) and of Stevens (1925) for *S. lycopersici.* The symptoms produced by the Philippine species in infection experiments on tomato, its host range, and its characteristics in culture are very similar to those reported by Norton (1917), Levin (1916), Briant (1932), and other investigators for *Septoria lycopersici* Speg.

The writers, therefore, consider the Philippine fungus on tomato similar to, if not identical with, *Septoria lycopersici* Speg.

TEST OF PATHOGENICITY

In order to test the pathogenicity of *Septoria lycopersici* Speg., two methods of inoculation were followed. The first consisted of pricking the leaves of the tomato with a sterile pin, and then smearing the fungus including part of its medium on the pricked portion. The control plants were pricked and smeared with medium without fungus on it. The second method of inoculation consisted of spraying the suspension of pycnospores in sterile water on the plants to be inoculated. The control tomatoes were sprayed with sterile water only. All inoculated and check plants were kept in the damp chamber until the disease appeared, and then the plants were moved to a shady place to allow the lesions to develop further. As soon as the symptoms produced in inoculation were found to be the same as those produced in the field, reisolations were made.

Experiment 1. On January 26, 1940, ten healthy tomato plants in pots of sterilized garden soil were inoculated by pricking and smearing spores and mycelium from pure culture on the wounded surfaces.

On February 2, 1940, symptoms of infection were noted. These consisted of indefinite small dark brown spots about the size of the head of a pin. The spots gradually enlarged and assumed a more or less circular shape with definite margins. The spots varied from grayish white to dark brown. Not infrequently the spots coalesced. The disease was favored by warm and moist conditions. The infected leaves dried out and subsequently fell off.

The fungus was reisolated successfully.

Experiment 2. On March 27, 1940, six healthy tomato plants were inoculated by smearing the leaves and stem with spores and mycelium of the fungus together with bits of potato-dextrose agar.

The inoculated plants showed symptoms of infection on April 2, 1940. Owing to the drying of the leaves and subsequent defoliation of the inoculated plants, only a little fruit was produced. The fruit failed to develop normally and dropped off prematurely.

Experiment 3. On April 26, 1940, flowers and fruit of two healthy tomato plants were sprayed with spore suspension of the fungus.

On May 2, 1940, the calyx of the flowers and the fruits including the peduncle were infected. Owing to the severe infection, the flowers dropped off and rotted. The inoculated fruit, however, developed to maturity, in spite of severe infection. Three weeks after inoculation, the infected mature fruit was collected and allowed to ripen. The seeds obtained from these were used in an experiment to determine whether or not the fungus is carried on the seeds.

Inoculation of different varieties of tomato

Five foreign varieties of tomato, namely, True Giant Ponderosa, Dwarf Giant, Sunny-brook Earliana, Marglobe, and Matchless, and two Philippine varieties, the Pear and Cherry were used. The seeds of these different varieties came from the Philippine Education Company, Manila. They were germinated separately in sterile soil in seed boxes. When the seedlings were about four centimeters high, they were transplanted in sterilized soil in earthen pots at the rate of 2 seedlings per pot.

Experiment 1. From May 2 to May 8, 1940, six one-month old plants of each variety were inoculated by smearing the upper and lower surfaces of the leaves with spore suspension of the fungus. Two plants of each variety served as control.

Infection was noted on all varieties 2 weeks after inoculation. A count of the lesions showed that on True Giant Ponderosa, 300 spots were produced on 62 leaves with an average of 5 spots per leaf; Dwarf Giant, 276 spots on 61 leaves with an average of 4.52 spots per leaf; Sunny-brook Earliana, 374 spots on 85 leaves with an average of 4.40 spots per leaf; Marglobe, 446 spots on 99 leaves with an average of 4.50 spots per leaf; Matchless, 380 spots on 82 leaves with an average of 4.63 spots per leaf; Native Cherry, 409 spots on 94 leaves with an average of 4.35 per leaf; and Native Pear, 370 spots on 87 leaves with an average of 4.25 spots per leaf.

Owing to the severity of the infection, 4 plants of the True Giant Ponderosa, 5 of the Dwarf Giant, 3 of the Sunny-brook Earliana, 3 of the Marglobe, 4 of the Matchless, 4 of the Native Cherry, and 2 of the Native Pear died of the disease 3 weeks after inoculation. The other plants which did not die early became defoliated except for a tuft of young leaves at the top. A few flowers were at times produced, but these dropped off prematurely, and no fruit was formed. Later, the plants died.

Experiment 2. From July 22 to July 27, 1940, six plants of each of the tomato varieties mentioned above were inoculated with the following results: True Giant Ponderosa, 450 spots on 86 leaves, the average being 5.23 spots per leaf; Dwarf Giant, 460 spots on 99 leaves, the average being 4.64; Sunny-brook Earliana, 366 spots on 81 leaves, the average being 4.51; Marglobe, 489 spots on 104 leaves, the average being 4.70; Matchless, 476 spots on 99 leaves, the average being 4.80; Native Cherry, 479 spots on 104 leaves, the average being 4.60; and Native Pear, 441 spots on 98 leaves, the average being 4.50 spots per leaf.

One month after inoculation, 5 plants of the variety True Giant Ponderosa, 4 of the Dwarf Giant, 5 of the Sunny-brook Earliana, 5 of the Marglobe, 4 of the Matchless, 3 of the Native Cherry, and 4 of the Native Pear died of infection. The plants that survived had but a small tuft of leaves at the apex of the plants at the end of the experiment.

No infection appeared on any of the leaves of the check plants. These plants grew to maturity and produced flowers and fruits.

The results of the two experiments show that the seven varieties of tomato used in the experiments are susceptible to *Septoria* leaf spot in about the same degree. These findings corroborate those of Levin (1916) and Norton (1917), who found that practically all tomato varieties grown in the United States and Europe showed the

same amount of *Septoria* blight on the foliage. Only varieties Currant and Ground Cherry were more or less resistant to *Septoria* leaf spot. Levin (1916), however, believes that systematists consider the Currant tomato as a different species and the Ground Cherry as belonging to the genus *Physalis*.

According to Andes (1939), the different varieties of common tomatoes show varying degrees of resistance to *Septoria* and *Macrosporium* leaf spots.

HOST RANGE OF THE DISEASE

Inoculation of solanaceous plants

On March 19 and again on April 8, 1940, four healthy seedlings of eggplant, 4 of pepper, 4 of tobacco, and 4 of potato were inoculated by smearing the upper and lower surfaces of the leaves with spore suspension of the fungus. Of these plants only the potato and eggplant showed infection in the form of definite small black spots on the leaves. These spots, however, did not increase in size very much. It was noted further that when the inoculated plants were placed outside of the inoculating chamber, the progress of the disease was practically checked. No spot was noted on the subsequent leaves of the plants.

The result of this experiment indicates that under very moist conditions other solanaceous plants may be infected. Evidently the conditions were very favorable for the development of the fungus but unfavorable for the hosts.

Inoculation of non-solanaceous plants

On May 4, 1940, plants outside of the Solanaceae, namely, ramie [*Boehmeria nivea* (Linn.) Gaudich.], strawberry, watermelon, cowpea, and colites (*Amaranthus viridis* Linn.) were inoculated by smearing the upper and lower surfaces of the leaves with spores and mycelium of the fungus. Even after an incubation period of 3 weeks, however, not one of the plants showed infection with the disease.

On June 29, 1940, papaya, patola (*Luffa acutangula* Roxb.), talinum (*Talinum patens* Willd.), talong punay (*Datura alba* Nees), gabi [*Colocasia antiquorum* (Linn.) Schott], corn, rice, and sugar cane were inoculated, but none of the plants became infected even after an incubation period of 3 weeks.

Norton (1917) produced infection with *Septoria* from tomato on 83 varieties of tomato, on eggplant, *Datura tatula* Linn., potato, and *Solanum carolinense* Linn.

SEASONAL OCCURRENCE OF THE DISEASE

Reed (1911) reports that, in 1910, the *Septoria* leaf spot of tomato spread widely in Virginia, U. S. A. during the wet weather in July, but was almost checked by a period of prolonged dry weather in August.

The disease was noted by the writers on tomato in the Department of Plant Pathology from October to January. After December the disease decreased in severity, and no *Septoria* infection could be found on tomato after March. The disease reappeared on the tomato in June, and it increased in severity in July and August. The new infections were attributed to the spores and mycelium of the fungus which remained in the soil and on leaves and stems of tomato plants which were infected in March.

LIFE HISTORY OF SEPTORIA LYCOPERSICI IN RELATION TO PATHOGENESIS

Transmission through seeds

Experiment 1. On January 10, 1940, seeds from infected fruits were collected and divided into lots A and B. Those in lot A were sterilized by immersion in 1:1000 mercuric bichloride solution for about one minute. The seeds were rinsed in water and germinated in sterilized soil in pots. Those in lot B were germinated in sterilized soil without sterilization. The pots were placed on benches far from previously infected plants for observation.

After one month the first sign of infection appeared on the cotyledon leaves of the plants in lot B, whereas all the plants in lot A were free from the disease. It was noted that the disease spread upward from the cotyledon leaves and infected the other leaves with increasing severity. The lower infected leaves of the plants gradually dried out and dropped off. These results show that the fungus may be carried on the seeds of the infected plants.

Experiment 2. On June 25, 1940, another experiment was conducted with seeds from a recently harvested diseased fruit. The seeds were also divided into lots A and B. Those in lot A were sterilized by immersion in 1:1000 mercuric bichloride solution for one minute and rinsed in sterile water before planting. Those in lot B were planted in sterilized soil without disinfection.

After one month, the first noticeable symptom appeared on the cotyledon leaves of the plants in lot B, whereas those in lot A remained free from the disease. On August 3, 1940, the disease was noted on the subsequent leaves. Before the end of the month prac-

tically all of the tomato plants in lot B showed the characteristic spots on their leaves.

Evidently the fungus is carried by the seeds externally in the form of spores. This is shown by the fact that sterilization of the surface of the seeds of infected plants was sufficient to keep the plants free from *Septoria* infection.

Dissemination by wind and water-splash

Experiment 1. On January 10, 1940, six healthy tomato seedlings were placed close to previously infected tomato plants outside the laboratory. Six other healthy seedlings were placed on one corner of the field far from the infected tomato plants. The plants in both lots were watered regularly by sprinkling their leaves with faucet water.

After three weeks the infection appeared on the tomato plants placed close to the infected ones, with those leaves nearer the sources of the inoculum showing more spots than those farther away.

It seems that rain water, or water splashed on the plant may carry the spores of the fungus from diseased leaves and from the ground to the healthy lower leaves of tomato or from the diseased leaves to those close by. The lower leaves of the plants or those close to the ground showed more infection than those leaves well above the ground.

Experiment 2. On June 24, 1940, twenty-four healthy tomato plants were placed outside of the laboratory at distances varying from one-half meter, one meter, one and one-half meters, two meters, two and one-half meters, and three meters away from four previously infected tomato plants. An equal number of healthy tomato plants were placed in one corner of the field far from the infected tomato. The plants in both lots were watered regularly by sprinkling them with faucet water. During the duration of the experiment there were occasional heavy rains and strong wind.

After three weeks, infection appeared on the plants which were closer to the infected tomatoes; those leaves nearer the sources of the inoculum showed more spots than those farther away. Infection was first noted on plants two and one-half meters away from the sources of infection. The other 24 healthy plants which were placed farther from the infected plants did not show any infection even after one month.

Dissemination of the fungus by insects

Experiment 1. On July 19, 1940, three adults of *Epilachna vigintioctopunctata* Fabr.[3] were collected from diseased tomato plants. The insects were shaken in a small amount of sterile water in test tubes in order to dislodge the spores on their bodies. The water was mixed with dissolved sterile potato-dextrose agar and poured into sterile Petri dishes. The Petri dishes were kept in the laboratory at room temperature. After 4 days, the cultures were examined, but no growth of *Septoria* was found on account of the luxuriant development of various other fungi on the agar.

Two other similar experiments were performed, but the writers failed to secure a pure culture of *Septoria.*

The writers attempted to isolate *Septoria* from the excreta of the larvae of *Plusia chalcytes* Fabr. which were feeding on infected tomato plants. Although several trials were made, a pure culture of the fungus was not obtained.

Experiment 2. On July 29, 1940, adults of *Epilachna vigintioctopunctata* Fabr. were collected from seriously infected tomato plants. They were picked with a sterile pair of forceps and allowed to crawl on sterilized potato-dextrose agar in Petri dishes. Three adults were freed in each of the 8 Petri dishes. In 4 of the Petri dishes the insects were removed after 15 minutes with a pair of forceps, whereas in the other 4 plates the insects were allowed to remain. The plates were kept in the laboratory at room temperature.

On August 3, 1940, fungous growths of what appeared to be *Septoria* were noted in all of the Petri dishes. Bacterial colonies and growths of other fungi, notably *Gloeosporium, Diplodia,* and *Aspergillus* were likewise observed.

Isolated growths of *Septoria* were transferred to slants of potato-dextrose agar. Before they were used in inoculation experiments, the cultures were purified by the single-spore-strain method (Keitt, 1915).

On August 10, 1940, young healthy tomato plants were inoculated with bits of mycelium and spores of the fungus. On August 17, 1940, the inoculated plants showed the characteristic *Septoria* infection on the leaves.

Dissemination through infested soil

Experiment 1. On June 14, 1940, twenty-two pots containing soil in which trash of previously infected tomato plants had been incorpor-

[3] The insects used in this study were determined by Dr. S. M. Cendaña, of the Department of Entomology.

ated were divided into groups 1 and 2. The soil in group 1 was sterilized in the autoclave at a pressure of 15 lbs. for one hour, whereas that in lot 2 was not. To each of the pots in both groups 3 tomato seeds which had been sterilized for 40 seconds to 1 minute in 1:1000 mercuric bichloride solution were planted. The pots were placed on benches in separate corners of the plot; those of group 1 were far from group 2. The plants in both groups were sprinkled with faucet water regularly.

On July 10, 1940, the first symptoms of the infection were noticed on the cotyledon leaves of the plants in group 2. On July 30, 1940, the disease gradually spread upward and infected the other leaves.

No infection was noticed on the leaves of the plants in group 1 even after the plants had reached the fruiting stage.

Stuckey (1915) and Levin (1916) report that the fungus continues to live on the trash and on greenhouse frames and sashes (Güssow, 1908). According to Levin (1916), spores of *Septoria* are easily disseminated by man through seeds of infected plants. The spores are also spread by water splashed during rain and by wind. Martin (1918) reports dissemination of spores of *Septoria* by insects and pickers. He found that in New Jersey the Colorado potato beetles (*Leptinotarsa decemlineata* Say) and their larvae, flea beetles (*Epitrix cucumeris* Harris), tomato worms (*Protoparce carolina* Linn.), and plant lice (*Aphis pseudobrassicae* Davis) spread spores of *Septoria lycopersici* and *Alternaria solani* (E. and M.) Jones and Grout.

How the fungus tides over adverse conditions

On April 10, 1940, spore suspensions were prepared from diseased leaves and stems of tomato which had been kept under a bell jar in the laboratory for 5 months. Some of the spores in the suspension were mixed with dissolved sterile potato-dextrose agar and then plated. After 48 hours the spores germinated in the agar. The spores likewise germinated after 48 hours on potato-dextrose agar in hollow ground slides. The result shows that the fungus can live between seasons on dry infected leaves and stems of tomato.

On May 29, 1940, spores from the dried leaves were placed on potato-dextrose agar and in water on hollow ground slides. The spores germinated in 48 hours.

It was noted, however, that the spores from the same source failed to germinate on July 5, 1940. They also failed to produce infection on young tomato plants on July 5 and August 2, 1940.

The results of the spore-germination tests show that the spores of *Septoria lycopersici* can remain viable on dried infected leaves for at least 6 months. After 8 months, however, the spores did not germinate any more.

Methods of infection

Healthy leaves of tomato were inoculated with spores from pure culture. Leaf sections were prepared from the inoculated leaves at intervals of 12 hours. The leaf sections were decolorized in 50-50 mixture of glacial acetic acid and 95 per cent alcohol for 24 hours, and then stained with Vaughan's (1914) method for differential staining of fungous and host cells.

Examination of the stained sections of leaves taken 48 hours after inoculation showed that the spores had germinated on the leaves. Well formed germ tubes were found, and some of these had penetrated the leaf through the stomata. It was noted that a young hypha either enters the stoma a few hours after germination or it may branch and grow over the surface of the leaf for some time until a branch finds a stoma. After entrance the mycelium ramifies in the leaf, especially in the spongy tissues. Five or six days later, as the infection becomes evident, the tissues appear water-soaked. Twelve days after the inoculation, the infected areas shrink slightly and take on a brownish color. Later, small and submerged pycnidia begin to form in the spots. The writers did not observe direct penetration of the leaf by the hyphae, although Chupp (1925) reported that *S. lycopersici* is capable of entering the host by direct penetration.

CONTROL MEASURES

Owing to the fact that *Septoria lycopersici* may be carried on the seeds in the form of spores, only seeds of healthy plants should be used for planting. Sterilization of the seeds with mercuric bichloride solution for about one minute and rinsing the seeds with sterile water before planting will destroy the spores of the fungus adhering to the seeds.

As the fungus can remain alive from season to season on diseased leaves and stems of tomato, it is suggested that old infected leaves be collected and badly diseased plants be pulled out and burned. Cleaning the field after every tomato season and destroying all sources of inoculum are good sanitary measures.

Experiments showed that different varieties of tomato may be infected by the disease with the same degree of severity. Eggplant

and potato, however, are only slightly attacked, whereas pepper, colites, and other vegetables are not infected by the disease. When severe soil infestation occurs and the disease becomes a factor in the production of tomato, other vegetables which are not affected by the disease should be planted.

SUMMARY

1. The *Septoria* leaf spot of tomato was noted on tomato cultures in Los Baños, Laguna, in October, 1939.

2. The disease produces on the leaves grayish to brown spots, which vary in size from 2 to 3 millimeters in diameter. The pycnidia of the fungus are formed on old spots.

3. The disease is caused by a fungus which is similar to, if not identical with, *Septoria lycopersici* Speg.

4. The fungus is destructive to tomato under humid conditions, but not when the surrounding atmosphere is more or less dry.

5. *Septoria lycopersici* infects tomato varieties True Giant Ponderosa, Dwarf Giant, Sunny-brook Earliana, Marglobe, Matchless, Pear, and Cherry with the same degree of severity.

6. Eggplant and potato are slightly affected by the disease; ramie [*Boehmeria nivea* (Linn.) Gaudich.], cowpea, colites (*Amaranthus viridis* Linn.), strawberry, watermelon, papaya, patola (*Luffa acutangula* Roxb.), talinum (*Talinum patens* Willd.), talong punay (*Datura alba* Nees), gabi [*Colocasia antiquorum* (Linn.) Schott], corn, rice, and sugar cane are immune to it.

7. The fungus penetrates the tomato leaves through the stomata. It lives from season to season on infected tomato leaves and stems in the form of spores and mycelium. The spores may be carried on the seeds of infected plants. They may also be spread by wind and water splashes when it rains.

8. The disease may be controlled by seed disinfection and destruction of the sources of inoculum.

9. Should *Septoria lycopersici* become a limiting factor in tomato culture, eggplant, which is less affected by the disease, or pepper, colites, cowpea, and other vegetables, which are immune to it, may be planted instead.

LITERATURE CITED

ANDES, O. J. 1939. Difference in susceptibility of tomato varieties to *Septoria* and *Macrosporium* leaf spots. Phytopath. 29: 750.

BRIANT, A. K. 1932. Tomato diseases in Trinidad. Tropical Agric. 9: 63–71.

CHUPP, CHARLES. 1925. Manual of vegetable garden diseases. v + 647 p. New York: The Macmillan Company.

DELACROIX, G. 1905. *Septoria lycopersici* Speg. Bull. Soc. Mycol. France 21: 170–172.

GÜSSOW, H. T. 1908. Septoria spot. A new fungus disease of tomato. Gard. Chron. Ser. 3, 44: 121–122.

KEITT, G. W. 1915. Simple technique for isolating single spore strains of certain types of fungi. Phytopath. 5: 266–267. *fig. 1.*

LEVIN, E. 1916. The leaf spot disease of tomato. Michigan Agric. Exper. Sta. Tech. Bull. 23: 7–49.

LONG, H. C. 1913. Tomato leaf spot. Gard. Chron. Ser. 3, 54: 417–418.

MARTIN, W. H. 1918. Dissemination of *Septoria lycopersici* Speg. by insects and pickers. Phytopath. 8: 365-372.

MCALPINE, D. 1903. Tomato leaf spot (*S. lycopersici* Speg.). Jour. Dept. Agric. Victoria 2: 70–71.

NORTON, J. B. S. 1917. Host limitations of *Septoria lycopersici* Speg. Phytopath. 7: 65.

PRITCHARD, FRED J., AND W. S. PORTE. 1924. The relation of temperature and humidity to tomato leaf spot (*Septoria lycopersici* Speg.). Phytopath. 14: 156–165.

REED, HOWARD H. 1911. Tomato blight and rot in Virginia. Virginia Agric. Exper. Sta. Bull. 192: 1–16. *Fig. 1–9.*

STEVENS, F. L. 1925. Plant disease fungi. xxi + 469 p., *illus.* New York: The Macmillan Company.

STUCKEY, H. P. 1915. Tomatoes. Georgia Exper. Sta. Bull. 112: 211–248.

TAUBENHAUS, J. J. 1918. Diseases of greenhouse crops and their control. vii + 429 p., *illus.* New York: E. P. Dutton & Company.

VAUGHAN, R. E. 1914. A method for the differential staining of fungous and host cells. Ann. Mo. Bot. Gard. 1: 240–241.

A COMPARATIVE STUDY OF CASSAVA REFUSE MEAL AND RICE BRAN AS FEEDS FOR GROWING AND FATTENING PIGS[1]

SOTERO P. PENULIAR

In the manufacture of cassava starch, a considerable amount of refuse is obtained. This refuse, after being dried and ground, produces cassava refuse meal, which is relished by pigs. Its feeding value has not, however, been determined.

The object of this study was to determine the comparative feeding value of cassava refuse meal and rice bran for growing and fattening pigs.

The work was conducted in the Department of Animal Husbandry from October 30, 1932, to May 28, 1933, covering a period of 210 days.

MATERIALS

Weanling pigs. Sixteen Berkjala weanling pigs, about ten weeks old at the beginning of the test, were used.

Feeds used. The feeds used and their prices in centavos per kilogram at the time the experiment was conducted were as follows: rice bran, 4.19; cassava refuse meal, 2.00; copra meal, 3.84; corn, 4.49; and shrimps, 14.52. The proportion of the different feeds by weight in the mixtures were:

Ration for the first 70-day period

FEEDS	LOT I	LOT II
Cassava refuse meal	0	60
Rice bran	60	0
Corn	15	15
Copra meal	20	20
Shrimps	5	5
Total	100	100

[1] Experiment Station contribution No. 1395. Prepared in the Department of Animal Husbandry under the direction of Assistant Professor Mariano Mondoñedo.

Ration for the second 70-day period

Feeds	Lot I	Lot II
Cassava refuse meal	0	60
Rice bran	60	0
Corn	20	20
Copra meal	17	17
Shrimps	3	3
Total	100	100

Ration for the third 70-day period

Feeds	Lot I	Lot II
Cassava refuse meal	0	60
Rice bran	60	0
Corn	25	25
Copra meal	15	15
Total	100	100

Mineral mixture used. To every 100 kilograms of the feed mixture, one kilogram of common salt and one of corn-cob charcoal were added.

The chemical analyses [2] of cassava refuse meal and rice bran used in the experiment were as follows:

	Cassava *per cent*	Rice bran *per cent*
Moisture	10.56	10.64
Fats	0.62	5.82
Ash	1.22	14.17
Protein	1.03	10.35
Crude fiber	4.66	12.73
Nitrogen-free extract	81.91	46.29
Calories per 100 gm.	346.00	286.35

Morrison (1939) [3] mentions cassava meal, or dried starch waste, which is probably the same as the cassava refuse meal under study, as having the following composition: moisture 12.00 per cent, fats 0.70, ash 1.60, protein 0.80, crude fiber 6.10, and nitrogen-free extract 78.80.

METHODS

Allotment of pigs. The pigs were divided into two lots. Allotment was made as uniformly as possible with sex, size, and condition taken into consideration.

[2] Analyses furnished by the Department of Agricultural Chemistry.

[3] Morrison, F. B. 1939. Feeds and feeding. Unabridged. 20th ed.; vi + 1050 p., 4 fig., 95 pl., Ithaca, New York: The Morrison Publishing Company.

Preparation of rations. The cassava refuse meal was originally in the form of cakes. These were ground to the consistency of rice bran. A stock feed mixture for each lot was prepared to last for one week.

Feeding. The pigs were hand-fed twice daily, the morning feeding between 6:00 and 7:00 a. m. and the evening feeding between 4:00 and 5:00 p. m. The rations were fed in a fairly thick slop; water was added just before feeding. The animals were given as much feed as they would readily consume.

Weighing. During the course of the test, individual weights were taken weekly. Weights were taken between 3:00 and 4:00 p. m. before feeding and after the pigs had been washed and allowed to dry.

Care and management. Except for the difference in the rations, the pigs were given the same treatment throughout the feeding trial. Between meals all animals were allowed to run together in a one-eighth hectare grass pasture. The pigs were sometimes given fresh camote vines at the rate of one per cent of their total live weight, to supplement the lack of good grass in the pasture. On warm days, at noon, the pigs were driven into the hog pen and were given a drink and a bath. During heavy rains and storms the animals were kept inside the hog house, particularly at night. The pigs had no shelter in the pasture other than that of acacia trees.

RESULTS

The results of the feeding tests are summarized as follows:

First 70-day period

	Lot I	Lot II
Average initial weight of pigs	8.04 kgm.	8.06 kgm.
Average daily gain in weight	0.20 "	0.09 "
Feed consumed per kgm. gained ...	3.50 "	7.02 "
Feed cost per kgm. gained	₱0.16	₱0.24

Second 70-day period

	Lot I	Lot II
Average initial weight of pigs	21.94 kgm.	14.07 kgm.
Average daily gain in weight	0.28 "	0.12 "
Feed consumed per kgm. gained ...	4.27 "	7.37 "
Feed cost per kgm. gained	₱0.19	₱0.23

Third 70-day period

	Lot I	Lot II
Average initial weight of pigs	38.23 kgm.	22.17 kgm.
Average daily gain in weight	0.21 "	0.13 "
Feed consumed per kgm. gained ...	5.96 "	7.98 "
Feed cost per kgm. gained	₱0.25	₱0.23

Whole 210-day period

	Lot I	Lot II
Average initial weight of pigs	8.04 kgm.	8.06 kgm.
Average final weight	52.65 "	34.73 "
Average daily gain in weight	0.21 "	0.11 "
Feed consumed per kgm. gained	4.58 "	7.49 "
Feed cost per kgm. gained	₱0.20 "	₱0.23 "

DISCUSSION OF RESULTS

First 70-day period. It may be seen from the above results that lot I pigs (rice bran) made an average daily gain of 0.20 kilogram, and lot II pigs (cassava refuse meal) 0.09 kilogram. Lot II was, therefore, only 45 per cent as efficient as lot I. Pigs in lot II ate less and took a longer time to consume their ration than lot I pigs.

From the standpoint of feed needed to make a kilogram of gain, lot I pigs required 3.50 kgm. feed and lot II pigs, 7.02 kilograms. The ration of lot II, therefore, was only 50 per cent as efficient as that of lot I in this respect.

The cost of feed to make one kilogram gain in lot I was ₱0.16 and in lot II, ₱0.24, or a difference of ₱0.08 in favor of lot I. This was true in spite of the greater feed consumption in lot I and the cheaper feed in lot II.

Second 70-day period. During this period, lot I pigs made an average daily gain of 0.28 kilogram and lot II pigs, 0.12 kilogram. Thus, lot II pigs were only about 43 per cent as efficient as lot I pigs.

From the point of view of the amount of feed needed to make a kilogram gain, lot I pigs required 4.27 kilograms while lot II pigs consumed 7.37 kilograms. Lot II pigs were only 58 per cent as efficient as lot I pigs.

The cost of feed to make one kilogram gain was ₱0.19 in lot I and ₱0.23 in lot II, or a difference of ₱0.04 in favor of lot I.

Third 70-day period. During the third 70-day period, lot I pigs made an average daily gain of 0.21 kilogram, and lot II pigs 0.13 kilogram. The ration of lot II was, therefore, 62 per cent as efficient as that of lot I.

Lot I required 5.96 kgm. to make a kgm. gain, and lot II, 7.98 kgm. Expressed in percentage, lot II was 75 per cent as efficient as lot I.

Two animals in lot II died at this time, animal 1779 of kidney worm infestation and animal 1747 of pleuritis. The poor quality of feed in lot I was probably a contributory cause of the death of these animals.

The cost of feed to make a kilogram gain in lot I was ₱0.25, and in lot II, ₱0.23; hence in lot II the feed cost per kilogram gained was two centavos less than that in lot I. It appears that cassava refuse meal had better feeding value for older pigs than for younger ones.

Whole 210-day period. The outstanding result obtained from the whole 210-day feeding test was that lot I consistently made the most rapid gain. Lot I made an average daily gain of 0.21 kgm. and lot II, 0.11 kgm. Cassava refuse meal was only 52 per cent as efficient as rice bran.

The average amount of feed required for one kilogram gain was 4.58 kilograms in lot I and 7.49 kilograms in lot II. In other words the latter was 61 per cent as good as the former.

In cost, one kilogram gain made by lot I cost ₱0.20 and by lot II ₱0.23, or a difference of ₱0.03 in favor of lot I.

SUMMARY

1. In rate of gain, cassava refuse meal as a substitute for rice bran in the College standard ration was only 45 per cent as efficient during the first 70-day feeding period, 43 per cent during the second, and 62 per cent during the last period. The percentage efficiency of cassava refuse meal compared with rice bran was 52 per cent during the whole 210-day feeding period.

2. As to the amount of feed required to make a kilogram gain, cassava refuse meal was only 50 per cent as efficient as rice bran during the first 70-day period; 58 per cent during the second; and 75 per cent during the last period, showing that it is more suitable for older pigs than for young ones. The average feeding efficiency of this feed as compared with rice bran for the whole 210-day feeding period was 61 per cent.

3. The cost of feed consumed per kilogram gained was ₱0.16 in lot I and ₱0.24 in lot II during the first 70-day period, ₱0.19 in lot I and ₱0.23 in lot II during the second period, and ₱0.25 in lot I and ₱0.23 during the third period. Cassava refuse meal may, therefore, be used economically in place of rice bran only during the last period. The feed cost to make a kilogram gain during the 210-day period was ₱0.20 in lot I, and ₱0.23 in lot II, a difference of 3 centavos in favor of lot I.

THE POTASH-FIXING CAPACITY OF SOME PHILIPPINE SOILS [1]

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Potash is one of the soil constituents essential in plant metabolism. In the cultivated soil, it is usually found in every limited amounts. For this reason, it has to be added to the soil from time to time. Plants grown in soils containing an insufficient quantity of available potash are not only susceptible to diseases but are also likely to exhibit symptoms of potash hunger. Crops grown on potash-deficient soils often produce poor yields; hence the application of potassic fertilizers to lands which have been under cultivation for a number of years is indispensable.

The addition of a certain amount of potash fertilizer to the soil may produce very little or no effect at all. Other things being favorable for plant growth, the failure of the added potash to increase the producing power of the soil may be attributed to the fixation of potash by either physical or chemical phenomenon. This fixation consists in converting the added potash into forms which are not available to the plants. More recent literature on soil fertility indicates that a knowledge of the potash-fixing capacity of soils is of importance for the successful use of potash fertilizers.

Blanck and Haselhoff (1928) state that Way (1850) was the first to note potash fixation in soils. Way found that only a fraction of the salt solution added to the soil is fixed. This finding was corroborated by Frear and Erb (1918), who reported that a large part of the potash added successively to the unlimed loam of the Pennsylvania Station was still present after thirty-six years. In connection with the potash-fixing capacity of soils, McGeorge (1914) determined the absorptive power of Hawaiian soils for fertilizer salts. He found that a knowledge of the potash-fixing power is necessary for work on soil fertility. Of the other workers on potash-fixing capacity of soils may be mentioned Schreiner and Failyer (1906), MacIntire,

[1] Experiment Station contribution No. 1396.

Shaw, and Sanders (1927), Bear (1929), MacIntire and Sanders (1930), Volk (1934), and Volk (1938).

The present work was carried out with the objects of (*1*) determining the potash-fixing capacity of some Philippine soils, and (*2*) finding out which of the soils show significant coefficient of correlation for the amount of K_2O fixed and pH value.

MATERIALS AND METHODS

The soil samples studied were portions of the samples whose organic matter and nitrogen contents were studied by Golez (1938) and whose phosphorus-fixing capacity was investigated by Galvez and Dinulos (1940). The method used to determine the potash-fixing capacity was that of Volk (1934). The hygroscopic value was determined in accordance with the technique of Rodewald-Mitcherlich (Wiesmann, 1926) and the pH value, in accordance with the potentiometric method using antimony electrodes in pairs with a saturated calomel half cell (Galvez, 1930).

RESULTS AND DISCUSSION

The soil samples from Baguio differ not only in the potash-fixing capacity but also in the hygroscopic and pH values. This is, of course, expected owing to the fact that soil is a heterogeneous body. The variations exhibited by the samples from Baguio are likewise shown by those from Bicol, Cavite, Maquiling area, Mindanao, and Cebu, although the ranges are not numerically equal. From these findings, it may be deduced that if one expects to be successful in carrying out soil management practices, like potash fertilization, soil hygroscopicity improvement, and liming, a previous knowledge of the potash-fixing capacity, hygroscopic and pH values of the individual soil is essential even if the soils are all from the same region. Because of the lack of uniformity of the soil properties herein determined, it is but natural that the best treatment in a certain area may not be applicable in another area in the same region.

The subsoils show results parallel to those revealed by the surface, as far as potash-fixing capacity, hygroscopic and pH values are concerned (table 1). In order to have a more comprehensive knowledge of the soils of the regions studied, tables 2, 3, and 4 have been prepared.

Table 2 shows the difference of the means and the standard error. It points out that, with the exception of the differences be-

tween Bicol-Maquiling, Bicol-Cebu, Cavite-Mindanao, and Maquiling-Cebu, which are all insignificant, all the differences in the mean amount of K_2O fixed by the surface are all significant. This result means that the samples from Baguio have higher potash-fixing capacity than those from Bicol, Cavite, Maquiling, Mindanao, and Cebu. Likewise those from Cavite and Mindanao have greater ability to fix potash than those from Bicol, Maquiling, and Cebu. This finding supports that of Schreiner and Failyer (1906), who found that different soils showed marked differences in their potash absorption.

The mean difference of the hygroscopicity (table 2) may induce one to assert that this property of soils tends to be more or less constant. Out of fifteen comparisons made, nine, or 60 per cent, showed identical values as indicated by their insignificant differences. The behavior of the pH value of the different regions is in general similar to that of the hygroscopicity.

Table 2 shows that, in the comparison of the potash-fixing capacity of the subsoils, insignificant variations are apparent only on Bicol-Maquiling, Bicol-Cebu, Maquiling-Mindanao, and Maquiling-Cebu; the rest are statistically appreciable. Table 2 further shows that the sub-soils of Baguio and Bicol are as hygroscopic as those of Mindanao and Maquiling respectively, whereas the other are all positively not identical. With regard to the pH values, it may be of interest to note that of the ten comparisons made, only four proved to have like values; the rest were non-concordant.

In the comparison of the mean amount of K_2O fixed, it is evident (table 3) that the surfaces and the subsoils of the five regions studied have agreeing potash-fixing capacity because the differences are all insignificant. Table 3 also shows that the subsoils are more hygroscopic than the corresponding surface with the exception of the samples from the Maquiling area whose hygroscopic values are identical as shown by the difference. On the other hand the pH value of the surface and the subsoil are seemingly concordant except that of the Maquiling area again where the surface proved to be less acidic than the subsoil.

Table 4 reveals that out of six correlation coefficients on the surface, for K_2O fixed and hygroscopicity and for hygroscopicity and pH value, only two for each are significant whereas for K_2O fixed and pH value, four are significant. The correlation coefficients in the subsoils corresponding to the above correlations support, in some cases, the facts brought out by their respective surfaces.

SUMMARY AND CONCLUSIONS

1. The soil samples within the same region showed marked differences in their ability to fix potash, pH value, and hygroscopic value. These variations were likewise apparent in the subsoils.

2. The Baguio soils proved to have higher potash-fixing capacity than those of Bicol, Cavite, the Maquiling area, Mindanao, and Cebu. Cavite and Mindanao samples, which had similar capacity in retaining potash, were better potash fixers than Bicol, the Maquiling area, and Cebu which happened to have statistically equal amounts of potash.

3. The subsoils of Baguio were like its surface—more efficient in fixing potash than those of Bicol, the Maquiling area, Mindanao, and Cebu. The other subsoils, with the exception of Maquiling and Mindanao, showed results parallel to their respective surfaces.

4. With regard to the potash-fixing capacity of the surface and the subsoils, there was no significant differences.

5. With the exception of the Maquiling area samples, the subsoils were more hygroscopic and acidic than their corresponding surfaces.

6. Significant coefficient of correlation for the amount of K_2O fixed and pH value was shown by the soil samples from Baguio, Bicol, Cavite, and the Maquiling area.

LITERATURE CITED

BEAR, FIRMAN E. 1929. Theory and practice in the use of fertilizers. vii + 120 p., New York: John Wiley & Sons, Inc.

BLANCK, E., UND E. HASELHOFF. 1928. Lehrbuch der Agrikulturchemie. 3. Teil. Bodenlehre 208p. Mit. 3 Textabbildungen. Berlin: Verlag von Gebruder Borntraeger.

FREAR, WM., AND E. S. ERB. 1918. Condition of fertilizer-potash residue in Hagerstown silty clay loam. Jour. Agric. Res. 15: 50–81.

GALVEZ, N. L. 1930. The use of the antimony electrode in the control of cane juice defecation and for measuring the hydrogen-ion concentration of soils. The Philippine Agriculturist 19: 219–227.

GALVEZ, N. L., AND C. C. DINULOS. 1940. The phosphorus-fixing capacity of some Philippine soils. The Philippine Agriculturist 28: 695–706.

GOLEZ, JOSÉ L. 1938. A study of organic matter and nitrogen contents of some Philippine soils. The Philippine Agriculturist 27: 85–96.

MACINTIRE, W. H., W. M. SHAW, AND K. B. SANDERS. 1927. The influence of liming on the availability of soil potash. Jour. Amer. Soc. Agron. 19: 483–505.

MacIntire, W. H., and K. B. Sanders. 1930. Potash fixation by liming materials. Soil Sci. **29**: 109–116.

McGeorge, Wm. 1914. Absorption of fertilizer salts by Hawaiian soils. Hawaiian Agric. Exper. Sta. Bull. **35**: 1–32.

Schreiner, O., and G. H. Failyer. 1906. The absorption of phosphates and potassium by soils. U. S. Dept. Agric. Bur. Soils Bull. **32**: 7–39.

Volk, Garth W. 1938. The nature of potash fixation in soils. Soil Sci. **45**: 263–276.

Volk, H. J. 1934. The fixation of potash in difficultly available form in soils. Soil Sci. **37**: 267–287.

Wiessmann, Hans. 1926. Agriculturchemisches Praktikum. Quantitative Analyse. ix + 329 p. Mit 95 Textabbildungen. Berlin: Verlagsbuchhandlung Paul Parey.

TABLE 1

Average amount of K_2O fixed, hygroscopicity, and pH value of some Philippine soils

REGIONS	K_2O FIXED PER 100 GRAMS OF SOILS	HYGROSCOPICITY	PH VALUE
	mgm.	*per cent*	
Baguio soils			
Surface	614.97	5.72	6.56
Subsoil	622.52	6.80	6.31
Bicol soils			
Surface	289.84	4.93	6.26
Subsoil	334.79	5.48	6.01
Cavite soils			
Surface	441.68	5.44	6.36
Subsoil	—	—	—
Maquiling area soils			
Surface	246.11	5.11	6.37
Subsoil	314.57	5.38	5.58
Mindanao soils			
Surface	437.32	5.35	6.65
Subsoil	491.43	6.47	6.42
Cebu soils			
Surface	169.69	3.92	5.33
Subsoil	218.06	4.38	5.25

TABLE 2

Comparisons of the mean amount of K_2O fixed, hygroscopicity, and pH value

REGIONS COMPARED	TOTAL DEGREES OF FREEDOM	DIFFERENCE OF MEANS			STANDARD ERROR OF DIFFERENCE			CONCLUSION BASED ON SNEDECOR (1938)[a]		
		K_2O	Hygroscopicity	pH value	K_2O fixed	Hygroscopicity	pH value	K_2O fixed	Hygroscopicity	pH value
		milligram	*per cent*		*milligram*	*per cent*		*milligram*	*per cent*	
Surface Baguio-Bicol Subsoil	44	325.13	0.79	0.30	43.81	0.22	0.12	H.S.	H.S.	S
		287.73	1.32	0.30	44.00	0.21	0.28	H.S.	H.S.	i
Surface Baguio-Cavite Subsoil	31	173.29	0.28	0.20	33.00	0.30	0.15	H.S.	i	i
		—	—	—	—	—	—	—	—	—
Surface Baguio-Maquiling Subsoil	28	368.86	0.61	0.19	30.81	0.35	0.10	H.S.	i	i
		307.95	1.42	0.73	20.21	0.22	0.14	H.S.	H.S.	H.S.
Surface Baguio-Mindanao Subsoil	33	177.65	0.37	0.09	34.62	0.31	0.10	H.S.	i	i
		131.09	0.33	0.11	57.30	0.22	0.10	S	i	i
Surface Baguio-Cebu Subsoil	27	445.28	1.80	0.23	29.42	0.12	0.10	H.S.	H.S.	S
		404.46	2.42	0.06	65.50	0.24	0.10	H.S.	H.S.	i
Surface Bicol-Cavite Subsoil	31	151.84	0.51	0.10	69.62	0.29	0.20	S	i	i
		—	—	—	—	—	—	—	—	—
Surface Bicol-Maquiling Subsoil	28	43.73	0.18	0.11	77.72	0.27	0.20	i	i	i
		20.20	0.10	0.43	64.48	0.32	0.17	i	i	S

[a] SNEDECOR, GEORGE W. 1938. Statistical methods. 388 p., 14.2 fig. Ames, Iowa: Collegiate Press, Inc.
i—Insignificant; S—Significant; H.S. Highly significant.

TABLE 2 (continued)

REGIONS COMPARED	TOTAL DEGREES OF FREEDOM	DIFFERENCE OF MEANS			STANDARD ERROR OF DIFFERENCE			CONCLUSION BASED ON SNEDECOR (1938)[a]		
		K_2O	Hygroscopicity	pH value	K_2O fixed	Hygroscopicity	pH value	K_2O fixed	Hygroscopicity	pH value
		milligram	*per cent*		*milligram*	*per cent*		*milligram*	*per cent*	
Surface Bicol-Mindanao	33	147.48	0.42	0.39	65.01	0.23	0.17	S	i	S
Subsoil		156.64	0.99	0.41	56.68	0.28	0.14	H.S.	H.S.	H.S.
Surface Bicol-Cebu	27	120.15	1.01	0.93	84.27	0.25	0.22	i	H.S.	H.S.
Subsoil		116.73	1.10	0.76	63.46	0.31	0.16	i	H.S.	H.S.
Surface Cavite-Maquiling	15	195.57	0.33	0.01	61.83	0.46	0.27	H.S.	i	i
Subsoil		—	—	—	—	—	—	—	—	—
Surface Cavite-Mindanao	20	4.36	0.09	0.29	65.47	0.43	0.26	i	i	i
Subsoil		—	—	—	—	—	—	—	—	—
Surface Cavite-Cebu	14	271.99	1.52	1.03	58.46	0.43	0.29	H.S.	H.S.	H.S.
Subsoil		—	—	—	—	—	—	—	—	—
Surface Maquiling-Mindanao	17	191.21	0.24	0.29	64.59	0.39	0.20	H.S.	i	i
Subsoil		176.86	1.09	0.84	86.59	0.33	0.26	i	H.S.	H.S.
Surface Maquiling-Cebu	11	76.42	1.19	1.04	55.78	0.38	0.21	i	H.S.	H.S.
Subsoil		96.51	1.00	0.33	82.29	0.27	0.29	i	H.S.	i
Surface Mindanao-Cebu	16	267.63	1.42	1.32	63.04	0.35	0.21	H.S.	H.S.	H.S.
Subsoil		273.37	2.09	1.17	80.88	0.10	0.22	H.S.	H.S.	H.S.

[a] SNEDECOR, GEORGE W. 1938. Statistical methods. 388 p., 14.2 fig. Ames, Iowa: Collegiate Press, Inc.
i—Insignificant; S—Significant; H.S.—Highly significant.

TABLE 3

Comparisons of the mean amount of K_2O fixed, hygroscopicity, and pH value of the surface and subsoils

REGIONS	TOTAL DERGEES OF FREEDOM	DIFFERENCE OF MEANS			STANDARD ERROR OF DIFFERENCE		
		K_2O fixed	Hygro-scopicity	pH value	K_2O fixed	Hygro-scopicity	pH value
		mgm.	*per cent*		*mgm.*	*per cent*	
Baguio							
Surface-Subsoils	44	7.53 i	1.08 H.S.	0.25 i	34.41	0.22	0.22
Bicol							
Surface-Subsoils	44	44.95 i	0.55 S	0.25 i	51.75	0.21	0.13
Maquiling							
Surface-Subsoils	12	68.46 i	0.27 i	0.79 S	81.53	0.39	0.28
Mindanao							
Surface-Subsoils	22	54.11 i	1.12 H.S.	0.23 i	67.48	0.32	0.19
Cebu							
Surface-Subsoils	10	48.37 i	0.46 S	0.08 i	49.23	0.18	0.20

i—Insignificant (Snedecor, 1938).
S—Significant (Ibid).
H.S.—Highly significant (Ibid).

TABLE 4

Coefficient of correlation between the amount of K_2O fixed and hygroscopicity, between hygroscopicity and pH value, and between the amount of K_2O fixed and pH value

REGIONS	NO. OF PAIRS OF DETERMINATIONS	DEGREES OF FREEDOM	SAMPLE VALUES OF R					
			K_2O fixed-hygroscopicity		Hygroscopicity-pH value		K_2O fixed-pH value	
			Surface	Subsoils	Surface	Subsoils	Surface	Subsoils
Baguio	23	21	0.15 i	0.17 i	0.04 i	0.25 i	0.42 S	0.14 i
Bicol	23	21	0.22 i	0.31 i	0.65 H.S.	0.36 i	0.55 H.S.	0.56 H.S.
Cavite	10	8	0.04 i	—	0.01 i	—	0.66 S	—
Maquiling	7	5	0.08 i	0.70 S	0.00 i	0.28 i	0.69 S	0.41 i
Mindanao	12	10	0.72 H.S.	0.66 S	0.49 i	0.09 i	0.46 i	0.09 i
Cebu	6	4	0.87 H.S.	0.79 S	0.76 S	0.87 H.S.	0.69 i	0.30 i

i—Insignificant (Snedecor, 1938).
S—Significant (Ibid).
H.S.—Highly significant (Ibid).

SCALE OF LIVING OF FRESHMAN STUDENTS IN THE COLLEGE OF AGRICULTURE[1]

MARCELO V. ARNALDO
Of the Department of Agricultural Economics

This paper discusses some aspects of receipts and expenditures of freshman students in the College of Agriculture, University of the Philippines, for the years 1934 to 1937, and 1938 to 1939. The data were obtained every month from the students' personal accounts, which form a part of the material in the class in farm accounting, a required course for freshman students.

The students were divided into two groups on the basis of means of support: group one composed of partially self-supporting students, and group two, composed of students who are entirely supported by their parents, relatives, or guardians. Living conditions and environment on the College campus may be considered more rural than urban. Usually, students do not become partially self-supporting until completion of the first semester of their freshman year. Unlike any college of the University of the Philippines in Manila, employment for working students in the College of Agriculture is limited. The College employs students as assistants, janitors, and laborers with wages ranging from ten centavos an hour for a maximum of 100 hours, or ₱10.00 per month, to sixteen centavos, or ₱16.00 per month. Others may be employed in private homes of faculty members on and outside the campus. These may receive free board and lodging and a monthly cash allowance ranging from ₱2.00 to ₱10.00, or their College matriculation fees may be paid by the employer. Students officially recognized as partially self-supporting are exempted from paying laboratory fees, thereby reducing their total expenses.

Each student in the farm accounting class, in which there were every year four to five sections of about 30 to 40 students each, was required to submit every month a personal account of classified receipts and expenditures.

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[1] General contribution No. 743.

Classified items of expenditures of freshman students in the College of Agriculture, 1934-1937 and 1938-1939

Board and room. Includes payment for board, room rent, light charge, kitchen expenses, etc.

Extra food and meals. Includes extra food (not refreshments) besides the regular meals served at the boarding house.

Books and education. Includes matriculation and other College fees, books, school supplies, student equipment, laboratory equipment, newspapers, magazines, class trips, etc.

Clothing, laundry, and personal expenses. Includes payment to laundry woman, purchases of new clothes, hats, shoes, ties, socks, toilet articles, and other personal expenses.

Transportation. Includes fares for car, calesa, taxi, train for business or pleasure trips to Manila and neighboring towns.

Refreshment and recreation. Includes all expenses for refreshments, cinematographs, dances, picnics, boxing bouts and athletics, society and club fees, contributions, etc.

Churches and benevolences. Includes contributions to public welfare as the Red Cross, Antituberculosis Society, churches, alms to beggars, etc.

Stamps and stationery. Includes purchases of paper, postage, and all forms of stationery.

Health. Includes purchases of medicines and drugs, doctor's bills, dental charges, etc.

Gifts. Includes all expenses for the purchases of fruit, ornamental plants, flowers, and birthday, Christmas, and other gifts.

Savings and investments. Includes loans, deposits in the bank, and money set aside each month.

Miscellaneous. Includes all other items not in the foregoing classification.

By using all the accounts submitted by the students every month during the four school years, 1934 to 1937, and 1938 to 1939, the writer obtained the average results (tables 1 and 2).

PLACES OF RESIDENCE

Most students live on the College campus, in Raymundo Barrio, and the Coconut Grove. On the College campus, there are four big

dormitories, seven bungalows, and houses owned by working students on Copeland Heights. The greater percentage of the freshmen, 30 to 50 per cent, reside on the campus. The place outside the campus popular to students is the Coconut Grove which lies just outside the main gate of the College. It had a freshman population ranging from 15 to 17 per cent of the total during 1934-1937. The Coconut Grove is the most populated and busiest spot in the College community. It has stores, restaurants, and recreational places like bowling alleys and pool rooms. On the whole, a greater proportion of the freshman students reside on the College campus.

LIVING QUARTERS

Living quarters of freshman students may be classified as follows: student's own house, club house, private house and dormitory, College dormitory, Protestant church dormitory, Roman Catholic church dormitory, and free lodging with parents and relatives, or lodging in exchange for work. There were a few, consisting of 6.15 to 14.4 per cent, who had their own homes on Copeland Heights. This district is a student barrio where students are allowed to build their own houses. In most cases, the student acquired his own house by purchase from departing students, or sometimes by falling heir to a house owned by other students who had been graduated. Students coming from the same province or region generally live together in clubs. Sometimes two or more students may join together and share the cost of constructing a house. In the event that a member of the club house wishes to leave, he may sell his right to the house.

In 1934-1935, 33.84 per cent of freshmen were members of clubs; in 1935-1936, 21.59 per cent; and in 1936-1937, 13.6 per cent. This club method of living was also found in the Coconut Grove outside the campus. A much bigger number, ranging from 28 to 34.09 per cent of the freshmen, had their living quarters in private houses and dormitories. From 15.38 to 27.27 per cent were living in College dormitories and bungalows. These students took full board in restaurants. A minority, consisting of from 1.6 to 7.2 per cent, had their living quarters in the Protestant church and Roman Catholic church dormitories, and from 1.14 to 4.62 per cent had free quarters with parents and relatives. Those living with College professors and in Molawin Hall (student mess hall) consisted of from 3.41 to 7.2 per cent.

BOARDING CONDITIONS

There were 2.27 to 6.15 per cent who cooked individually their own meals, but as many as from 24 to 35.39 per cent preferred the club method as it is more economical. In this club method, members take turns in cooking the meals, apportioning all living expenses incurred during any given month. Students living in a club house, however, are not necessarily members of the cooking clubs. Others were cooking part of their meals and buying the viands from restaurants, but only 6.15 per cent were found in 1934-1935 cooking in this way. The majority of the freshmen were paying for three prepared meals each day. Those partially self-supporting freshmen earned their board by working in private homes of College professors. A few lived with parents or relatives. Those having free board consisted of 3.41 to 13.85 per cent as compared to those on full board which ranged from 38.46 to 70.40 per cent.

EXPENDITURES

An examination of the expenditures of students reveals that many of the accounts showed deficits in certain months, others broke even, and a few showed a surplus. The causes of deficits as shown in the balance were (*a*) frequent trips to the city and neighboring towns, (*b*) entertaining friends, (*c*) dancing, and (*d*) membership in two or more student associations or organizations. In this manner, the spendthrift may spend in advance more than his monthly allowance from home. This accounts for the fact that in some cases the total expenditures appeared greater than the total receipts. The partially self-supporting group spent relatively less than the entirely supported group. The expenditures of the partially self-supporting group ranged from ₱15.00 per month in 1934-1935 to ₱29.40 per month in 1936-1937, whereas those of the entirely supported students ranged from ₱22.82 in 1935-1936 to ₱50.95 in 1936-1937. The three years average of the two groups shows that among the partially self-supporting students, those working in private homes outside the campus for board and room spent only ₱17.82 per month; those working in private homes on the campus for wages ₱23.66; and student laborers, ₱23.10 (table 1). The entirely supported group spent over ₱10.00 more than the self-supporting group. Those supported by parents or relatives spent ₱32.22 per month; those supported by parents alone, ₱39.07; and by guardians, ₱44.23 (table 1).

An analysis of the expenditures by groups shows that expenses were highest for two items, namely, for board and room and for

books and education (table 1). Of the partially self-supporting group, the expenditures for board and room ranged from 27.35 to 28.87 per cent of the total expenditures per month, whereas of those entirely supported, these expenditures ranged from 30.43 to 37.51 per cent. Expenses for books and education ranged from 35.89 to 42.93 per cent in the case of the partially self-supporting group, and from 25.19 to 26.85 per cent for those entirely supported (table 1). It should be noted, however, that in the case of those partially self-supporting students who worked in private homes in exchange for board and room, no charge for these items were made; hence this affected somewhat the results of this group. It will be seen from the results of the study (table 1) that while partially self-supporting students spent much less than those entirely supported, the relative expenditures for the various items do not show significant differences.

When the data obtained in 1938-1939 were tabulated in a different way, i.e., according to ranges of receipts, the expenditures of the freshman students per month varied in direct proportion to the receipts. The average monthly receipts per student in 1938-1939 ranged from ₱15 to ₱63.57 (table 2). Again it will be noted that the student's expenditures per month in most cases were over his allowance. This happens because a student after two or three months of residence on the campus is able to establish credit with his boarding house and other stores; hence his expenses in certain months may be greater than his receipts. When the various items of expenditures were expressed in percentages (table 2), the groups whose ranges of receipts were from ₱20.00 to ₱29.00, and from ₱30.00 to ₱39.00 per month spent relatively the most for board and room (36.76 per cent to 39.75 per cent for board and 7.71 per cent to 7.95 per cent for room), but the least for refreshments and recreation (2.75 per cent to 2.78 per cent). On the other hand, the groups whose ranges of receipts were from ₱40.00 to ₱49.00 and from ₱50.00 and above spent the least for board and room (29.72 per cent to 29.74 per cent for board and 6.26 per cent to 6.50 per cent for room) but the most for refreshments and recreation (4.18 per cent to 4.59 per cent). The group of students who received the average minimum allowance per month of ₱15.00 spent 25.91 per cent for books and education, the highest among all groups. This low income group, however, spent the least for room (5.46 per cent), extra food and meals (2.79 per cent), transportation (0.28 per cent), stamps and stationery (0.44 per cent), and savings (0.28 per cent). For all groups it may be said that the average freshman spent most of his allowance or income for board (32.94 per cent), books and education (20.07 per

cent), clothing, laundry and personal expenses (15.59 per cent), room (6.76 per cent), and miscellaneous (5.61 per cent) (table 2).

OTHER ITEMS OF EXPENDITURE

It will be noted that four additional items are added in the classification of expenditures for 1938-1939 (table 2). These are room, extra food and meals, stamps and stationery, and gifts. Table 2 shows that the expense for board varied on the average from ₱6.50 to ₱19.00 per month. The regular rates for board in restaurants ranged from ₱11.00 to ₱18.00 per month. The apparent discrepancy in the above result was due to the fact that some students were cooking part of their meals and others were hiring cooks to prepare their food. The expense for board per month of these groups was as low as ₱4.00 for those cooking part and as high as ₱20.00 for those who had a hired cook.

The expense for room per student ranged from ₱0.98 to ₱4.00 per month (table 2). The rates per month in the College dormitories and bungalows were ₱2.50 and ₱2.00, respectively, including light and water. When furnished with bed, table, and chair, the rooms were rented at ₱3.00 per month including light and water. At the Y. M. C. A. dormitory, furnished rooms were rented for ₱3.00 or ₱4.00 per month. Rates in private homes on and outside the campus and in private dormitories ranged from ₱1.50 to 5.00 per month, including light and water. Students living in student-owned houses in Copeland Heights paid only a certain amount corresponding to his share in the cost of building the house. The share might be as low as ₱10.00, which entitled him to occupy the room during his stay in the College.

The attitude of freshman students toward contributions to religious, charitable, and social enterprises was one of indifference. The community has very little to expect from them. The expenditures in this regard were very meager. The column "church and benevolences" in tables 1 and 2 will indicate that less than one per cent of the students' money is given to charity and church.

Toward saving, the attitude of the freshman students was slightly more encouraging. The laboring students are generally judicious in spending. Table 1 shows that students working in private homes for board and room were able to save, on the average, 10.04 per cent of the total expenditures for the month. Those supported by parents and guardians saved 3.28 and 1.17 per cent, respectively. Those supported by parents and relatives saved 4.59 per cent which

is higher than that of the other groups. This may be expected on account of the fact that the students classified under this group had two sources of support. Records show that only laboring students generally deposited their savings in the postal savings bank. Foreign students, however, put aside their surplus in banks in Manila. The habit of thrift among these students under study was obtained from their records of personal accounts and from the observation of the writer. Students from Ilocano regions surpass those of other regions in their ability to save. They were seldom seen in refreshment parlors and restaurants standing "treats" for friends as liberally as the Visayans; however, they did not seem to be stingy in the gratification of their own individual desires. Chinese students also were observed to possess a similar trait.

SUPPLEMENTARY INCOME

On first entering the College, the laboring students had enough money to last them until they could find work to supplement their meager receipts from home. Some of those employed by the College as student laborers and janitors in the latter part of the year could still earn more money by doing extra work for outsiders on Saturdays and Sundays. Receipts from these sources are classified as earned. These were the supplementary income which some resourceful students received in addition to their regular allowance from home.

TENTATIVE STUDENT BUDGET

The important point in the student's budget which should be considered is finding a wise balance between (*1*) academic needs, (*2*) essential requirements of daily living, and (*3*) social needs and recreation. The average total expenditures in tables 1 and 2 and their distribution found in this study may be safely recommended as a guide in as far as the College of Agriculture standard of student living is concerned. One who can sacrifice some of the good times of student life may choose from the lower bracket incomes and still obtain the knowledge and all that a formal College education offers.

A student, therefore, who is judicious and wise in his expenditures may find these accompanying tables useful as a tentative budget.

CONCLUSION

The budget needs of a student in connection with living expenses can only be understood by a complete examination of his monthly expenditures. From the results of the study, it may be said that

the student's average allowance of ₱20.00 or less hardly meets adequately his needs. This inadequacy, however, may either be subjective or objective. The objective shortages, however, are important. They are wholesome recreation, vacation, travel, and adequate food varieties. Student spending is ruled by the available income or money received from home. Table 2 clearly indicates this tendency. The fundamental justification of student expenditures, from the parents' point of view is that the student passes his subjects every year with fairly good grades. Whether or not the receipts and expenditures of students in this institution can be increased depends ultimately in part on changes in the cost of living as affected by the purchasing power of the peso.

IMPERIAL BUREAU OF PASTURES & FORAGE CROPS
LIBRARY
ABERYSTWYTH, GREAT BRITAIN.

TABLE 1

Summary of receipts and expenditures of freshman students in the College of Agriculture; average per student per month (three-year average, 1934–1937)

CLASSIFICATION OF FRESHMAN STUDENTS	RECEIPTS					
	Unearned		Earned		Total receipts	
	pesos	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
Partially self-supporting students:						
Working in private homes outside the campus for board and room	22.21	84.45	4.09	15.55	26.30	100.00
Working in private homes on the campus for wages	20.29	90.62	2.10	9.38	22.39	100.00
Student laborers[a]	16.47	66.01	8.48	33.99	24.95	100.00
Entirely supported students:						
Parents—relatives	36.01	100.00	—	—	36.01	100.00
Parents alone	39.21	100.00	—	—	39.21	100.00
Guardians	39.46	100.00	—	—	39.46	100.00

[a] Students working in the College for wages.

TABLE 1 (continued)

CLASSIFICATION OF FRESHMAN STUDENTS	EXPENDITURES													
	Total expenditures		Board and room		Clothing, laundry, and personal expenses		Books and Education		Refreshments and recreation		Transportation		Health	
	pesos	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
Partially self-supporting students:														
Working in private homes outside the campus for board and room	17.82	100.00	—	—	4.24	23.79	7.65	42.93	0.67	3.76	1.53	8.59	0.26	1.46
Working in private homes on the campus for wages	23.66	100.00	6.47	27.35	4.08	17.24	8.98	37.95	0.80	3.38	1.21	5.11	0.17	0.72
Student laborers[a]	23.10	100.00	6.67	28.87	3.48	15.06	8.29	35.89	0.64	2.77	1.04	4.50	0.45	1.95
Entirely supported students:														
Parents-relatives	32.22	100.00	10.63	32.99	4.47	13.87	8.62	26.76	1.57	4.87	2.12	6.58	0.26	0.81
Parents alone	39.07	100.00	11.89	30.43	5.94	15.20	10.49	26.85	2.27	5.81	3.36	8.60	0.48	1.23
Guardians	44.23	100.00	16.59	37.51	7.04	15.92	11.14	25.19	2.16	4.88	2.16	4.88	0.69	1.56

[a] Students working in the College for wages.

TABLE 1 (continued)

CLASSIFICATION OF FRESHMAN STUDENTS	EXPENDITURES					
	Church and benevolences		Savings and investments		MISCELLANEOUS	
	pesos	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
Partially self-supporting students:						
Working in private homes outside the campus for board and room	0.05	0.28	1.79	10.04	1.63	9.15
Working in private homes on the campus for wages	0.04	0.17	0.38	1.61	1.53	6.47
Student laborers [a]	0.07	0.30	0.35	1.52	2.11	9.14
Entirely supported students:						
Parents-relatives	0.25	0.78	1.48	4.59	2.82	8.75
Parents alone	0.15	0.38	1.28	3.28	3.21	8.22
Guardians	0.11	0.25	0.52	1.17	3.82	8.64

[a] Students working in the College for wages.

TABLE 2

Expenditures of freshman students in the College of Agriculture according to ranges of receipts; average per student per month, 1938–1939

RANGES OF RECEIPTS	NUMBER OF STUDENTS	RECEIPTS	
		Total	receipts
		pesos	*per cent*
10–19	31	15.00	100.00
20–29	41	25.50	100.00
30–39	14	36.00	100.00
40–49	4	41.00	100.00
50 and above	12	63.57	100.00
For all groups	—	36.21	100.00

TABLE 2 (continued)

RANGES OF RECEIPTS	EXPENDITURES													
	Total expenditures		Board		Room		Extra food and meals		Books and education		Clothing, laundry, and personal expenses		Transportation	
	pesos	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
10–19	17.94	100.00	6.50	36.23	0.98	5.46	0.50	2.79	4.65	25.91	3.65	20.36	0.05	0.28
20–29	25.16	100.00	10.00	39.75	2.00	7.95	0.79	3.14	4.00	15.90	4.87	19.36	1.50	5.96
30–39	38.91	100.00	14.30	36.76	3.00	7.71	0.80	2.05	8.60	22.10	4.88	12.54	2.01	5.17
40–49	53.80	100.00	16.00	29.74	3.50	6.50	1.70	3.16	10.75	19.98	8.09	15.04	4.30	7.99
50 and above	63.92	100.00	19.00	29.72	4.00	6.26	4.78	7.48	12.11	18.95	9.68	15.14	3.45	5.40
For all groups	39.95	100.00	13.16	32.94	2.70	6.76	1.71	4.28	8.02	20.07	6.23	15.59	2.26	5.66

TABLE 2 (continued)

RANGES OF RECEIPTS	EXPENDITURES													
	Refreshments and recreation		Church and benevolences		Stamps and stationery		Health		Gifts		Savings		Miscellaneous	
	pesos	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*	*pesos*	*per cent*
10–19	0.57	3.18	0.02	0.11	0.08	0.44	0.10	0.56	—	—	0.05	0.28	0.79	4.40
20–29	0.70	2.78	0.05	0.20	0.20	0.79	0.40	1.59	0.25	0.99	—	—	0.40	1.59
30–39	1.07	2.75	0.03	0.08	0.75	1.93	0.20	0.51	1.00	2.57	—	—	2 27	5.83
40–49	2.47	4.59	0.10	0.19	1.24	2.30	0.37	0.69	0.50	0.93	0.80	1.49	3.98	7.40
50 and above	2.67	4.18	0.34	0.53	1.17	1.83	0.68	1.06	0.80	1.25	1.48	2.32	3.76	5.88
For all groups	1.50	3.75	0.10	0.25	0.69	1.73	0.36	0.90	0.51	1.28	0.47	1.18	2.24	5.61

COLLEGE AND ALUMNI NOTES

The College observed Loyalty Day on October 10 with Hon. Benigno S. Aquino, Secretary of Agriculture and Commerce, as the guest of honor. The theme of this year's celebration was self-sufficiency.

The day was featured by a parade, aërial demonstrations by Philippine Army aviators, program, alumni meeting, athletics, and a dance.

In the program, Secretary Aquino reviewed at length the Commonwealth's activities in pursuing its program towards economic self-sufficiency.

The winning floats in the parade were of: Department of Agronomy, first; Los Baños Economic Garden, Bureau of Plant Industry, second; Bureau of Forestry including School of Forestry, and Department of Agricultural Education including U. P. Rural High School, honorable mention.

A fairly large group of College alumni were here on Loyalty Day, October 10. The group includes the following:

Aala, F. T. '34
Abesamis, A. '21
Arriola, F. '34
Bacomo, P. U. '16
Bagalso, C. F. '31
Bagui, C. '22
Balasico, B. M. '37
Camus, J. S. '14
Capco, S. R. '31
Catalan, N. '20
Clara, F. M. '20
Crucillo, C. '25
Cruz, E. E. '25
Dinglasan, M. '34
Dinulos, C. '37
Eala, Q. '27
Erce, P. '32
Evangelista, R. '37
Fernandez, C. '34
Flores, F. de Leon '35
Galang, F. G. '14
Gaviola, V. D. '29
Losbañez, N. '39
Luna, J. G. '37
Mabbun, P. N. '23
Macabasco, C. B. '37
Macasaet, M. '35
Madamba, A. '39
Magsino, J. R. '22
Mane, A. M. '29
Mañgila, A. '40
Manio, R. V. '20
Marfori, R. T. '30
Marquez, F. D. '15
Medrana, A. '39
Medrana, C. '27
Mendoza, I. P. '21
Merino, G. '14
Ortiz, P. F. '33
Otanes, F. Q. '18
Paguirigan, D. B. '16
Pamintuan, M. C. '33
Pangga, G. A. '33
Perez, I. V. '36

Gesmundo, A. E. '30
Gonzales, S. S. '25
Gordon, A. '23
Goseco, F. '26
Hemedes, J. D. '36
Hernandez, B. '22
Inciong, A. '27
Inumerable, S. '36
Jamias, J. '20
Jesus, R. C. de '36
Juliano, J. B. '23
Leon, Jose de '16
Lontok, A. M. '20
Lopez, F. R. '37
Lopez, L. R. '36
Platon, A. V. '36
Recidoro, H. C. '38
Reveche, F. '23
Rodrigo, P. A. '21
Romero, I. '41
Rozul, J. B. '32
Serrano, L. L. '39
Silayan, H. S. '17
Tecson, A. '34
Teodoro, N. G. '15
Tiglao, S. '28
Torres, J. B. '19
Unite, J. O. '21
Villadolid, D. '19

The graduation of the following students from the College was approved by the faculty at its meeting on October 15, 1940:

Bachelor of Science in Agriculture

Francisca S. Bandong
Antonio C. Bello
Lorenzo O. Cañizares
Esteban Y. Castillo
Feliciano L. Cruz
Napoleon D. Dignadice
Lorenzo B. Duque
Domingo M. Endrinal
Agustin M. Escarrilla
Sawaeng Kulthongkham
Isauro M. Lazaro
Felipe A. Maclang
Chan Meesukh
Gregorio G. Melegrito
Chalem Natatat
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Associate in Agriculture

Bartolome R. Luardo

The Laguna Chapter No. 1, U. P. Alumni Association, held its annual meeting on October 10. The members were addressed by Director Hilarion S. Silayan of the Bureau of Plant Industry, who spoke on "Our Mutual Problems".

The local chapter elected its officers for the current term as follows: Francisco O. Santos, president; Gerardo O. Ocfemia, vice-president; Francisco M. Fronda, secretary-treasurer; and Nemesio B. Mendiola and Nicanor G. Teodoro as additional members of the Executive Board.

THE EXPERIMENT STATION

LIST OF AVAILABLE CIRCULARS

Circular No. 2.—Bud Rot of Coconut (Revised, June, 1934) - - - *By G. O. Ocfemia*

Circular No. 3.—Experimental Errors and Application of the Probable Error to and the Interpretation of Experimental Results - - - - - - - - - - - - - *By Nemesio B. Mendiola* (Published as Chapter IV in *A Manual of Plant Breeding for the Tropics*, 1926, also sold by THE PHILIPPINE AGRICULTURIST at ₱3.25, paper bound, and ₱5.25, cloth bound, in the Philippines, and ₱3.50 and ₱5.50 elsewhere, postpaid.)

Circular No. 5.—Poultry Raising Made Easy (Revised) - - - - *By F. M. Fronda*

Circular No. 7.—How to Produce New Varieties of Gumamela (Hibiscus) - - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 8.—Horse Breeding in the Philippines - - - - - *By Valente Villegas*

Circular No. 9.—Fences for Farm Animals - *By B. M. Gonzalez and J. P. Esguerra*

Circular No. 10.—Practical Directions for Coffee Planting - - - *By Pedro A. David*

Circular No. 11.—The New College Copra Drier—Prepared in *Department of Agricultural Chemistry* with cooperation of *Department of Agronomy and Extension*. (Revised by *Moises M. Kalaw*).

Circular No. 14.—Beriberi: Its Causes and Prevention - - - - - *By F. O. Santos*

Circular No. 15.—Cattle Raising under Philippine Conditions - - *By Valente Villegas*

Circular No. 16.—A Simple Farm Record for the Farmer - - *By Francisco M. Sacay*

Circular No. 17.—College Trapnest - - - - - - - - *By F. M. Fronda and P. S. Paje*

Circular No. 18.—Surveying for Area with a Surveyor's Staff - *By Alexander Gordon*

Circular No. 19.—A Pageant: Illustrating the History and Growth of the College of Agriculture - - - - - - - - - *By Anne F. Cole*

Circular No. 20.—Amount of Nutrients in Philippine Food Materials - - - - - - - - - *By F. O. Santos and S. J. Ascalon*

Circular No. 21.—Cassava Growing and Cassava Starch Manufacture - - - - - - - - - - - *By Nemesio B. Mendiola*

Circular No. 22.—Goat Raising - - - - - - - - - - - - - - *By Valente Villegas*

Circular No. 23.—Curing Pork and Making Sausage for Home Use - - - - - - - - - - - - - - - *By Mariano Mondoñedo*

Circular No. 24.—Construction and Operation of Silos in the College of Agriculture - - - - - - - - - - - - *By José P. Esguerra*

Circular No. 26.—Training Cattle and Carabaos for Work - - - *By Valente Villegas*

Circular No. 27.—Bunchy-top of Abacá - - - - - - - - - - - *By G. O. Ocfemia*

Circular No. 28.—Cotton Culture - - - - - - - - - - - - *By Eulalio P. Baltazar*

Circular No. 29.—Collegiate Education in Agriculture - - - - *By L. B. Uichanco*

Circular No. 30.—What Should Filipino Ornamental Gardens and Ornamental Plants Be? - - - - - - - - - - *By N. B. Mendiola*

Circular No. 31.—How to Slaughter and Dress Farm Animals - - - - - - - *By Valente Villegas and M. Mondoñedo*

The Circulars Nos. 1, 3, 4, 6, 12, 13, and 25 are out of print.

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